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STATISTICS AND THE SCIENTIFIC METHOD[1]

By Malcolm C. Rorty

There has been growing up, it would seem, from year to year, a feeling that the addresses made on occasions such as the present should not run in too serious a vein, but should, on the contrary, serve in some measure as a relief from the scientific rigidity of our formal papers.

This feeling was undoubtedly shared by my distinguished predecessor in office, whose brilliant address of last year will long be remembered as a most perfect blend of humor and sound philosophy.

Yet the very perfection of my predecessor's effort furnishes but one more example of the vanity of human aspirations. He had hoped, I am sure, to establish a precedent whereby the presidential address of this society should serve each year as a mental oasis in which the thirsty explorer of our annual sessions might regale himself at the springs of humor and fancy. But the very quality of his effort was its own undoing—for it is certain that, so long as the memory of my predecessor's oration shall linger, no president of this Association will attempt to rival its special perfections.

I shall, therefore, take my inspiration in soberer fashion from the complaint, made not long ago by the president of another scientific society, that the statisticians were attempting to absorb the whole range of the sciences into their special keeping. As this particular complainant put the case, he was in doubt as to the action he should take. He might stand by and let nature take her course, as with La Fontaine's frog that burst in the attempt to become an ox. Or he might head a movement to carve up the Statistical Association and distribute the portions in appropriate manner among the other scientific organizations.

[1] Presidential address at the Ninety-second Annual Meeting of the American Statistical Association, December 31, 1930.

Fortunately these plans have, as yet, remained in abeyance. It may, however, be well for statisticians to take advantage of this breathing space to set their house in order—to establish their proper place in the cosmic scheme of things and to make their peace with the other scientific disciplines.

In their beginnings, the statists were the agents of statescraft in the computation of possible military levies in men, money, and materials. And in this capacity they presumably learned to compute the first coefficient of correlation—that between the burden of the various levies and the number and seriousness of revolutionary uprisings.

By reason of their special concern with the imposition of taxes these early statisticians were, I am afraid, of lowly popular repute, and there may have been more than a subtle malice in the thought that led the ancient town of Nuremburg to equip the lower floors of the house of the hangmen's guild as a meeting place for statisticians—and, I regret to say it, for economists, also.

Today, however, the picture is different. As one of our newspaper editors put it sometime ago, "The once lowly statistician has become lord of the business cycle"—even though I suspect that the economic statistician may be more inclined, in these recent months, to think of himself as a harried nursemaid of a very unruly child.

Furthermore, the myriad applications of statistical technique to economic problems are but a fraction of the growing total in a still wider range. Each day sees new applications in commerce and industry, in jurisprudence, in medicine, in politics, and, in fact, in every old and new angle of human activity. And finally, in the field of the physical sciences, the mathematical analysis is taking on more and more of a statistical form, and the whole body of these sciences seems to be threatened with an ultimate absorption and consolidation into a mathematical complex of the sort of which statistical dreams are made.

When we survey this broadening and apparently unlimited field for the application of the statistical technique, it is in the nature of things that the question should be asked by the other scientific disciplines, and by statisticians themselves, "What is a statistician?"

In attempting to answer this question, I naturally turn to my own personal experience. Not many years ago I found myself associated with a small group of very practical statisticians, who were called upon to effect a rapid and considerable expansion of their activities. The immediate problem was that of selecting and hiring a properly qualified staff. It was urgently necessary to answer the question, "What is a statistician?"

We started in the orthodox manner by calling in a variety of candidates for the new positions and by examining them in the usual way as to education and past experience. But our experience with the first few candidates was unpromising. They might be well trained in theory, they might be experienced in the mechanics of statistics, but the divine fire seemed to be lacking.

We began, then, to search for new methods of selection. The period in question was that immediately following the Great War, when much interest still existed in the intelligence ratings that had been developed for military purposes. We, therefore, decided to begin our examination of candidates by submitting them to the army intelligence tests. And here we obtained at least a beginning of the solution of our problem, for we discovered the very interesting fact that no candidate who failed to pass these tests, with a rating well up in that range necessary for officers' rank, could by any possibility become a real statistician.

But this was only the first small step in our task, for even those candidates who passed the military tests with high ratings were only in small fraction qualified to become statisticians. So we set ourselves next to the preparation of a super-examination, that should separate the statistical wheat from the chaff in the group that had survived the initial tests—and in this we were finally successful to such an extent that we discovered an almost absolute correlation between the rank of a candidate in the super-examination and his subsequent practical value to us as a statistical performer.

Yet, in the working out of this super-examination, the most interesting feature was not so much its practical usefulness as the entirely new picture that developed in answer to the question, "What is a statistician?" As the examination gradually took shape and became more effective for its purposes, it became less statistical in form and was more and more concerned with tests of the logical faculties.

One of our original questions was as to the general time of day in which the full moon rose, and why. But, unfortunately, this simple inquiry floored nine out of ten of the college professors. So we had to substitute an easier problem, which, I believe, originated with Herbert Spencer. The candidate was told to assume that married men as a class lived longer than single men, while at the same time the act of marrying shortened each individual man's life. He was then asked to reconcile the two assumptions—and it is needless to say that he got a zero rating if he gave us the classical answer that married life only seemed to be longer.

In the final development of our examination, it became composed entirely of non-technical questions similar to the preceding. We

discovered, in fact, that it was of small importance whether a candidate could, or could not, work out a coefficient of correlation, provided he knew instinctively when to distrust one. And in the end we found ourselves placing technically trained statisticians, mathematicians, and actuaries under the supervision of skilled logicians—of men who might have to learn the details of statistical technique, but who started with an instinctive knowledge of the scientific method as a whole.

This, then, was our pragmatic answer to the question, "What is a statistician?"—the statistician must be instinctively and primarily a logician and a scientist in the broader sense, and only secondarily a user of the specialized statistical techniques. The statistician who knew only statistics was a danger and a blight. It was less important to know how to use statistics, than it was to know how and when *not* to use them.

But this was not the only lesson we learned from this special experience. We were constantly being requested to advise regarding the organization of statistical departments, and in many cases were asked to make specific recommendations as to the appointment of statisticians by business and industrial organizations. The latter requests were particularly difficult to handle. We found that we could rarely advise in good faith the appointment of even the best trained statistician who was unfamiliar with the business that he was to analyze. And we finally found ourselves making two distinct types of recommendations. Where a man was available within the business organization, who was well trained in the business and was a natural logician and analyst, we always recommended that such man be placed in charge of the statistical division and be backed up by one or two juniors trained in the details of statistical technique. On the other hand, if no such man was available within the organization, we suggested the alternative procedure of engaging a man skilled in logical processes and statistical technique, and giving him as thorough a training as possible in the details of the business, before calling upon him to analyze its operations.

This again was an unexpected result from our experience, and its special interest for the present occasion lies in the fact that it indicates rather clearly, I believe, the position and true functions of the Statistical Association.

Statisticians as a group will hold indefinitely their traditional interest in census work and vital statistics, and in public statistics as a whole—and they will thus, of necessity, maintain specially close contacts with the social sciences. Nevertheless, the primary field for the activities of the Statistical Association will always be that of the development

and extension into use of a correct and effective statistical methodology, as a thing apart from specific applications. The statistical work in astronomy must be done primarily by astronomers, and in biology by biologists, and in each science by those who are trained primarily in that science and only secondarily in the statistical method. To these scientists the Statistical Association can extend only coöperation in methodology and a convenient meeting place for comparisons and interchanges of statistical technique.

There is, however, a growing field in which the Statistical Association may function with very great usefulness. It is difficult to limit, even if it were desirable to do so, the extension of the scientific method into new fields—nor can we say that advertising and marketing, or industrial organization, or even the art of investing, may not become in time as true sciences as any of those that are today recognized by that name.

This scientific pioneering must of necessity be mainly, if not wholly, statistical in nature, and it is here that this Association plays a specially useful part as a source of inspiration and guidance for those who are taking the first steps in the application of exact research in new fields and to new ranges of human activity.

The Statistical Association has, in fact, become a unique meeting ground in which the utmost refinements of the scientific method come face to face with the most practical of practical affairs. It is the gathering place, above all others, where scientific men tend to become practical and practical men tend to become scientific. This very special characteristic of the Association's activities confers a great opportunity, and at the same time imposes a great obligation, upon technically trained statisticians and teachers of statistics. There is special need for the translation of the statistical philosophy into simple language and of the statistical technique into simple rule of thumb formulae similar to those used by engineers and other practical technicians.

The statistician in commerce and industry, or in any one of the newer fields of practical applications, tends very properly to work with a minimum of mathematics. Yet it is highly important that he shall work scientifically and shall have a very clear conception of the circumstances under which the mathematical refinements of technique may be applied with safety and profit.

In considering the refinements and modifications of the scientific method which particularly apply to the work of the statistician, the first point to be emphasized is that the statistician is always dealing with probabilities and degrees of uncertainty. He is, in effect, a Sherlock Holmes of figures, who must work mainly, or wholly, from

circumstantial evidence. And, just as the Sherlock Holmes of fiction must prove by successive steps, first, that the murder was committed, and, second, that the suspect had a motive for the crime and was on the scene at the critical moment, and, finally, that no one else could have been guilty—so the statistical detective must learn to approach each complicated problem from as many independent angles as possible and must combine and weigh and balance the results of the different solutions at which he arrives.

In this connection the criminal parallel is too tempting not to be carried a step further—for the trained worker will never complete and pass final judgment upon an analysis without first appointing counsel for the defense. In other words, after establishing his proof, he will promptly set to work, in person or by capable proxy, to show that the whole demonstration, if it proves anything at all, leads to the exact opposite of the conclusions originally announced.

If the statistician can learn thus wholeheartedly to wreck his own fondest hopes in the manner I have described, he will have taken his first firm step in the scientific pathway. And, to gain fortitude for further steps, he may console himself with the thought that if he should pursue his statistical prey through the thickets of uncertainty and should hang the culprit finally on the gallows tree of fact, that very success might be his own undoing and might add him to the great army of the unemployed. It is, in fact, fortunate for the profession that so many of our problems—and most notably our old friend the business cycle—are living under suspended sentences, and require constant surveillance.

But Sherlock Holmes is proving too tempting an illustration, and I must get back to fundamentals.

When the pioneer statistician has once realized the importance of setting up, so far as possible, not only one, but several, independent proofs of his conclusions, he must next learn to state these conclusions in accurate and useful terms. These must cover not only the most probable values or relations, but also the reasonable maximum limits of variation, or, for practical purposes, the range within which there are nine chances in ten, or ninety-nine chances in one hundred that the true results will lie.

At this point the scientific pathfinder is perhaps ready to consider certain refinements of the inductive-deductive method. As practically applied, this method is, however, rarely the simple sequence of observation, hypothesis, and statistical verification that is described in the text books, but usually involves many successive alternations of these processes. In the attack on a blind problem it is always necessary to

assemble the perfectly obvious data, and then to examine such data to determine what collateral figures are required—and frequently this alternation between the collection, and the examination and expansion of data must be repeated several times before the first tentative hypothesis can be developed to indicate cause and effect relations, or the lines along which controlled statistical experiments may be conducted.

As the next stage in his education, it is important that the statistical pioneer shall realize, once for all, that a coefficient of co-variation may not properly be described as a coefficient of correlation until the possibilities of chance co-variation have been calculated. I am not sure, in fact, that statistical science might not gain greatly if the coefficient of correlation should be defined as a coefficient of co-variation, supplemented by a calculation of the chances that such co-variation may be accidental. Furthermore, it is not possible to emphasize too often the fact that even a coefficient of correlation thus safeguarded establishes no presumption whatever as to cause and effect relations between the variables. This must be my excuse for calling attention to the very high correlation that undoubtedly exists between the number of truckmen on the New York City streets and the percentage of sulphur in the New York City air. On superficial examination of this coefficient, the technically trained observer might find the source of the sulphur in the exhaust gasses of the trucks—while other observers specially familiar with the environment might find the source of the sulphur in the vitriolic language that the truckmen use in their more animated and stressful moments. However, it is needless to say that a scientific study of the phenomena would probably indicate that both sulphur and trucks were functions of business activity.

But here, again, I am wandering away from the serious treatment that statistical problems deserve. The crimes are numberless that are committed in the name of the coefficient of correlation, and particularly in the name of the multiple correlation of time series. Our experts might, therefore, perform a real service by developing mathematically, as I believe they can, the fact that any random time series, however extended, may be expressed with increasing accuracy in terms of other similar random series, as the number of such other series is increased. This is particularly true when the element of time advance or lag is introduced. The coefficient of correlation is bad enough as a measuring stick—it is wholly impossible as an argument.

Along lines similar to the preceding, it has long since been demonstrated that any time series, random or otherwise, may be completely resolved by the harmonic analysis, without such resolution having any

significance whatsoever with respect to inherent regular periodicities in the data. And in the reverse direction it has repeatedly been shown that practically all our economic time series can be reproduced in substantial facsimile by the mere throwing of dice. Yet a naïve belief in the regularity of economic cycles persists, and crops up perennially in new forms, regardless of both fact and theory.

The dangers that lie in undue reliance upon coefficients of correlation, the harmonic analysis, and other forms of rigid mathematical treatment of complex statistical data can hardly be overestimated. I am inclined, in fact, to believe it should be a matter of fundamental principle for all statistical conclusions to be reached primarily through logical and experimental processes, supplemented by very simple numerical and graphical analysis. The more elaborate mathematical treatment should then be applied, if necessary, as a check and verification of the results that have been arrived at by these other means.

I had hoped, on this occasion, to touch briefly on each of the fundamental operations of the statistical procedure and to suggest, at least very tentatively, those modifications that might result from a purely logical and non-mathematical analysis. But even the simplest of our statistical operations, when thus approached, rose up, so to speak, and demanded a full chapter, at least, for an adequate treatment.

When we smooth a statistical series, are we justified in eliminating variations that are not provably within the limits of error in observations or of known chance irregularities in data? And if we go further, by eliminating variations due to isolatable cause and effect relations, in order to observe more readily those variations that are due to unknown causes, is not this an adjustment of the data for our special and immediate purposes, rather than a true smoothing—and does not the same point of view apply when we arbitrarily suppress short term variations in order to study more closely those of longer periodicity?

Similar questions arise when we consider our equally common practice of interpolation and extrapolation. How can we determine the probable error in such operations, as a thing apart from the chances of actual changes in trend? What differences in probable error arise when we extrapolate along the lines of logically justified mathematical curve forms, rather than by means of expirically determined or arbitrary curves? How far can such probable errors be determined mathematically, and to what extent must they be estimated on the basis of the statistician's intimate knowledge of the data?

These illustrations of the logical problems that arise when we consider even the simplest of our statistical procedures might be continued indefinitely. Only during the last few weeks I have had occasion to

set up a great variety of economic growth curves on a per capita basis, and have been amazed to discover how many of such curves could be represented with a high degree of accuracy by plotting them on an arithmetic time scale in terms of the cumulation of a normal frequency distribution. To state this fact in other words, the majority of these curves can be plotted as straight lines on Hazen's cumulative probability paper, using a simple arithmetic time scale as the base.

Such plotting is very effective for automobile registrations, automobile replacement demand, telephone and electric light and power development, and many other economic and industrial trends that are headed toward definite per capita saturations. I do not need to say that the fitting of growth curves to straight lines on this special plotting paper has little significance when only a fraction of a curve is concerned. However, this significance becomes very great when an exact fitting is obtained with respect to a growth curve that has approached within 20 to 30 per cent of its saturation point.

The statistical results just referred to are of special interest, beyond their immediate practical applications, insofar as they furnish one more example of the tendency for the mathematical characteristics of the normal frequency distribution to crop up in unexpected places. This persistent tendency seems to justify the assumption now being made by many mathematical investigators that the great part of all frequency distributions would be of the normal form if we could deal directly with the items that really varied. Here, again, I believe that our experts can render a special service by continuing their investigations and by setting up the philosophy of frequency distributions and mathematically related series in such manner that the statistical pioneer may use this philosophy as a practical guide in his investigations.

But I am perhaps venturing into deep statistical waters, so let me revert to my earlier comparisons and a more immediately practical point of view, by suggesting the importance of the statistical third degree.

The verification of conclusions by means of controlled statistical experiments is very rarely possible in the social sciences, and the impracticability of such experiments results too often in excessive reliance upon theory and pure correlations. Nevertheless, there are many direct verifications of cause and effect relations in economic phenomena that, while fragmentary and incomplete in themselves, may still be of convincing value in combination with the results of other analyses.

As a specific and somewhat odd illustration, we may take the correlation between daily weather conditions and the lunch time patronage

of restaurants. On first examination, the situation is confusing. Some restaurants show a positive correlation between fine weather and the number of lunches served. Others show a negative correlation, and still a third group reveal no definite correlation whatever.

From the standpoint of pure statistics the problem is perhaps insoluble. Yet a few direct inquiries will not only reveal the real facts, but add an unexpected significance to the data.

Stormy weather reduces somewhat the total number of lunches eaten in restaurants. But its more important effect is to drive custom into unattractive nearby restaurants, that in fair weather would go to more attractive restaurants at a distance. The attractive restaurant shows a positive correlation between trade and sunshine. The unattractive restaurant profits from cloudy skies.

Another example of this practical form of verification is in connection with the assumption that there is a direct cause and effect relation between interest rates on second mortgages and the volume of building construction. It has been stated that the reduced building activity of recent months was directly ascribable to the high cost of second mortgage financing. Nevertheless, even the most sketchy inquiry of those directly concerned with the handling of second mortgages will show that the difficulty lies not in a shortage of second mortgage money, but in a shortage of second mortgage confidence. The real obstacle to construction at the present time is the fear that building investments made at current levels of cost, and in the face of apparent building surpluses, might be wholly unprofitable.

It is this checking of circumstantial evidence by the forcing of a direct confession from the statistical culprit that may properly be described as the application of the statistical third degree. And no professional sentimentalism should be allowed to prevent a full development of the possibilities of this procedure. The statistician, as the chief pathfinder among scientific pioneers, must necessarily combine that vision which comes from fertility, breadth, and incisiveness of hypothesis, with the balance and sureness of step of the scientific method as a whole. But, above all, he must possess something of the rude spirit of the frontiersman and must seek his results in every legitimate way, regardless of refinements of method and rigidity of conventions.

THE INFLUENCE OF POPULATION DENSITY ON CRIME

By Reginald E. Watts, *Chief Statistician on Criminal Statistics, Dominion Bureau of Statistics, Canada*

In treating of crime it is first necessary to determine what classes of offences should be considered as crimes. It is obvious that the great bulk of the cases disposed of in the magistrates' courts throughout the country cannot be, and are not included in the category of criminal cases. The great majority of the police court cases are breaches of municipal by-laws and regulations and other trivial offences, which vary in different places, and do not directly indicate the criminal trend. Therefore, for these analyses, a selection has been made from the reports of criminal statistics, of offences which indicate the actual criminality. These are the convictions recorded for indictable offences.

The term indictable means an offence which is triable on an indictment, that is to say the legal process by which a bill of indictment is preferred to, and presented by a grand jury. An indictment differs from an *information* which rests only on presentation by the prosecuting authority, and properly from a *presentment* which is an accusation originating with the grand jury. The word is sometimes loosely used, however, to include an information or presentment or both. Many cases of indictable offences are proceeded with, without a formal indictment. Furthermore certain cases triable on indictment may also be disposed of summarily by a magistrate, according to the severity, or circumstances of the cases.

Criminality, then, as represented in these pages, is based upon convictions for indictable offences, whether proceeded with before a jury, or by a judge without the intervention of a jury, or summarily before a magistrate. As the proportion of cases dealt with by the three processes changes from year to year we take the category of crime as defined by the criminal code rather than that as defined by the method of procedure in disposing of the cases.

The figures do not represent the total *amount* of crime for the reason that it was necessary, in order to measure the *trend* accurately, to eliminate female offenders on account of the unequal proportion that exists between the sexes in regard to crime and population. That is to say, approximately 95 per cent of the crimes are committed by the male half of the population. It might be argued that juveniles under 16

years of age are not criminals, but merely delinquents. However, it is obviously necessary to include these for sake of comparisons, and analytical purposes. Their inclusion is also consistent with our classification of crime from the point of view of heinousness, not from that of procedure.

The gross crime figures of males with the same reduced to index numbers are given in Table I, also the male population over 15 years of age, for the year 1891 and for each year from 1901 to 1929.

TABLE I

GROSS CRIME INDEX, 1891 AND 1901 TO 1929

(Males only, of 7 years of age and over—both for crime and population)

Year	Number of convictions	Index figures of gross crime	Population in thousands[1]
1891	3,568	67.6	2,024
1901	5,275	100.0	2,279
1902	5,286	100.2	2,352
1903	6,046	114.5	2,428
1904	6,288	119.2	2,512
1905	7,143	135.4	2,599
1906	7,670	145.4	2,691
1907	8,620	163.4	2,780
1908	10,753	203.8	2,879
1909	10,986	208.7	2,981
1910	10,833	205.3	3,077
1911	11,887	225.3	3,189
1912	14,676	278.2	3,322
1913	17,285	327.6	3,462
1914	20,703	392.4	3,607
1915	15,517	370.0	3,520
1916	15,004	284.4	3,474
1917	12,725	241.2	3,468
1918	14,426	273.2	3,501
1919	15,835	300.2	3,573
1920	16,178	306.6	3,685
1921	17,364	329.2	3,765
1922	17,586	333.3	3,824
1923	17,146	325.4	3,894
1924	18,675	354.0	3,957
1925	19,574	370.9	4,030
1926	19,965	378.4	4,113
1927	21,326	404.3	4,199
1928	24,102	456.9	4,288
1929	26,394	500.3	4,370

[1] See explanation of estimated population in the paragraph immediately following Table VII.

Examination of the total number of convictions reveals that during the first ten years, 1891–1901, crime increased 47.9 per cent or 4.8 per cent per annum. The next decade, 1901–1911, shows a growth of crime from 5,275 to 11,887, an increase of 124.3 per cent or 12.4 per cent per annum. From 1911 to 1921 the increase was 4.6 per cent a year and during the last nine years, 1921–1929, the average increase was 5.2 per cent a year. The period of the most rapid growth in crime was during the seven years ended 1914, the year of the outbreak of the World War, during which time crime increased 92.5 per cent, but fell off 38.5 per cent during the next three years. The 1914 figure of 20,703 was not reached again until the year 1927, which shows 21,326. The total in-

crease in the actual number of crimes during the thirty-nine years was 639.7 per cent.

The index numbers are based on the figures of 1901 taken as 100, which show that the crime trend rose from 67.6 in 1891 to 500.3 in 1929, or taking the 1891 figures as 100 the 1929 numerals would read 739.7.

Now the question arises—how much of this trend of increase is due to the trend of population growth? It will be observed that the population increase was much lower than that of crime. During the whole period the population increase was but 115.9 per cent against 639.7 per cent for crime. As the population increases crime increases at a still greater rate. Is there any connection between the crime rate (apart from the volume of crime) and the population growth, size or density?

In investigating the extent to which the volume of crime from time to time is built up solely by the size of the population it is not enough to strike per capita rates. A per capita rate assumes that all the individuals of the population are equally responsible for the crimes committed. We cannot allow this assumption for one moment because we are constantly faced with the fact that even the bare physical volume of the population must take into consideration two main features as well as a simple count of heads, *viz.*, age distribution and sex. Consequently instead of expressing the rate of crime as a bare per capita rate it would seem necessary to find a simple expression which takes into consideration the size of the population giving due weight to the ages and the sex.

For this investigation the number of crimes committed by the male population divided as to ages, into four groups, 7–15, 16–20, 21–39 and 40 and over, is shown in Tables II and III. These give the total number of crimes, also the percentage for each group to the total, for 1891 and for each year of the period 1901–1929.

We see here that the percentage differs considerably in the different groups, but it will be observed that the groups comprise periods of unequal lengths, nine years in the first, five in the second, nineteen in the third, with the fourth more or less indefinite. But as these are the groups into which the crimes are divided in the criminal statistics reports there is no other alternative but to use them. The necessary per capita adjustments will be made later. In the meantime it is of interest to note, from Table III, that the depression in the crime rate during the war years was confined principally to the two older groups. The juvenile group did not decrease at all and the next group, 16–20, declined only during the year 1916. This falling-off during the War by the older groups appears to be traceable to two material causes in addition to any

TABLE II

NUMBER OF CONVICTIONS BY AGE GROUPS, 1891 AND 1901 TO 1929

Year	7–15	16–20	21–39	40 and over	Total
1891	609	687	1,769	503	3,568
1901	1,051	907	2,501	816	5,275
1902	901	973	2,553	859	5,286
1903	1,100	1,005	3,005	936	6,046
1904	751	1,238	3,304	995	6,288
1905	861	1,399	3,841	1,042	7,143
1906	948	1,466	4,017	1,239	7,670
1907	1,284	1,568	4,417	1,351	8,620
1908	1,476	1,991	5,773	1,513	10,753
1909	1,454	1,788	6,072	1,672	10,986
1910	1,589	1,795	5,645	1,804	10,833
1911	1,662	1,832	6,599	1,794	11,887
1912	2,222	2,141	8,207	2,106	14,676
1913	2,763	2,735	9,629	5,158	17,285
1914	3,193	3,308	11,485	2,717	20,703
1915	3,570	3,259	10,109	2,579	19,517
1916	3,459	2,002	7,424	2,119	15,004
1917	3,658	2,051	5,504	1,512	12,725
1918	4,076	2,929	5,704	1,657	14,426
1919	3,948	3,831	6,195	1,861	15,835
1920	3,484	3,139	7,571	1,984	16,178
1921	3,377	3,380	8,344	2,263	17,364
1922	3,861	3,208	8,240	2,277	17,586
1923	4,006	2,810	7,587	2,743	17,146
1924	4,359	3,288	8,184	2,844	18,675
1925	4,673	3,624	8,487	2,790	19,574
1926	4,743	3,442	8,726	3,054	19,965
1927	4,787	3,932	9,240	3,367	21,326
1928	4,736	4,469	10,957	3,940	24,102
1929	4,836	5,597	11,963	3,998	26,394

TABLE III

PERCENTAGE OF TOTAL CONVICTIONS BY AGE GROUPS, 1891 AND 1901 TO 1929

Year	7–15	16–20	21–39	40 and over	Total
1891	17.1	19.2	49.6	14.1	100.0
1901	19.9	17.2	47.4	15.5	100.0
1902	17.1	18.4	48.3	16.2	100.0
1903	18.2	16.6	49.7	15.5	100.0
1904	11.9	19.7	52.6	15.8	100.0
1905	12.1	19.5	53.8	14.6	100.0
1906	12.4	19.1	52.3	16.2	100.0
1907	14.9	18.2	51.2	15.7	100.0
1908	13.7	18.5	53.5	14.3	100.0
1909	13.2	16.3	55.3	15.2	100.0
1910	14.7	16.6	52.1	16.6	100.0
1911	14.0	15.4	55.5	15.1	100.0
1912	15.1	14.5	56.0	14.4	100.0
1913	16.0	15.8	55.7	12.5	100.0
1914	15.4	16.0	55.5	13.1	100.0
1915	18.2	16.8	51.8	13.2	100.0
1916	23.1	13.3	49.5	14.1	100.0
1917	28.7	16.1	43.3	11.9	100.0
1918	28.3	20.2	40.0	11.5	100.0
1919	25.0	24.2	39.1	11.7	100.0
1920	21.5	19.4	46.8	12.3	100.0
1921	19.5	19.5	48.0	13.0	100.0
1922	21.9	18.2	46.9	13.0	100.0
1923	23.4	16.4	44.2	16.0	100.0
1924	23.4	17.6	43.8	15.2	100.0
1925	23.9	18.5	43.3	14.3	100.0
1926	23.8	17.2	43.7	15.3	100.0
1927	22.5	18.2	43.3	16.0	100.0
1928	19.7	18.5	45.5	16.3	100.0
1929	18.3	21.2	45.3	15.2	100.0

psychological effect the War undoubtedly had in sobering the minds of the people. One of these causes may be attributed to the absence from Canada of nearly half a million men, of mature age, overseas. The other implied cause is the floating population produced by immigration.

In this connection it is necessary to investigate the conditions with respect to immigrant arrivals in Canada during the period under review. A statement of this is given in Table IV.

TABLE IV

IMMIGRANT ARRIVALS, 1901 TO 1928

Year	Arrivals	Year	Arrivals
1901	49,149	1915	144,789
1902	67,379	1916	48,537
1903	128,364	1917	75,374
1904	130,331	1918	79,074
1905	146,266	1919	57,702
1906	189,064	1920	117,336
1907	124,667	1921	148,477
1908	262,469	1922	89,999
1909	146,908	1923	72,887
1910	208,794	1924	148,560
1911	311,084	1925	111,362
1912	354,237	1926	96,064
1913	402,432	1927	143,991
1914	384,878	1928	151,597

Note the heavy influx of immigrants during the period 1910–1914, the same period during which the crime rate rose so rapidly, and the subsequent falling-off of arrivals after the commencement of the War, with the concurrent decline in crime.

That there is a floating population attributable to immigration is revealed on further investigation. In the census reports we find the figures given in Table V.

TABLE V

YEAR OF IMMIGRATION OF THOSE IN CANADA IN 1921

Arrivals prior to 1900	332,073
Arrivals 1900 to 1910	742,072
Arrivals 1911 to 1914	523,483
Arrivals 1915 to 1918	116,128
Arrivals 1919	69,985
Arrivals 1920	103,663
Arrivals January 1 to June 1, 1921 (date of Census)	41,631
Total	1,929,035
Arrivals, year not given	26,701

Total immigrant population according to census 1911=1,494,946
Total immigrant population according to census 1921=1,955,736

Now these figures reveal some striking facts. In Table IV we see, for instance, during the period 1911–1914, that 1,452,631 immigrants arrived, but the census of 1921 tells us there were in Canada at

that date only 523,483 immigrants who arrived during that period, which leaves a discrepancy of 929,148 of those four years' arrivals. How long did they remain in the country? Taking the next period, 1914–1918, the arrivals amounted to 327,774, but the census of 1921 recorded only 116,128 of these, a further loss of 211,646. An allowance must be made for the death rate, which would not, however, be very significant. During the ten year period 1911–1921, 1,875,443 immigrants arrived; add these to the 1,494,946 who were in the country in 1911 and there should be 3,370,389 (not allowing for deaths) here in 1921, but we had 1,955,736! Allowing for deaths, there is evidence of over a million immigrants who left Canada during the decade. This condition must not be lost sight of when considering the crime trend.

Another point of real significance that must be touched upon is the age distribution of immigrants. Examination of the records reveals that approximately 50 per cent range between 18 and 29 years of age. The figures for one year (1928) are given in Table VI.

TABLE VI

AGE GROUPS OF MALE IMMIGRANT ARRIVALS FOR 1928

Age groups	Total male arrivals	Per cent of the total
0– 9	9,976	9.9
10–17	8,096	8.1
18–29	50,757	50.6
30–49	27,972	27.9
50	3,475	3.5
Total arrivals	100,276	100.0

It will readily be seen from this table and from the preceding facts brought out that there are several elements which tend to disturb the regular trend of the population, particularly with respect to that part of the population whose ages range between 20 and 40, from which the bulk of the criminal class emanate. Therefore it is obvious that these phenomena must exert an influence on the trend of crime.[1] It is also obvious that the gross figures and the index based on the same as shown in Table I do not represent the true crime rate. A true per capita

[1] From the census figures we find that the proportion of immigrant population was 13.0 per cent in 1901, 22.0 per cent in 1911 and 22.2 per cent in 1921. The percentages of the crime committed by this immigrant population for corresponding years was 21.1, 39.8 and 36.5. Notice that the relative proportions of immigrant population and immigrant crime do not vary materially at the three census years; also that there are no indications that they are more criminal than others when we take into consideration the fact that immigrant arrivals were largely males and at the age at which most crimes are committed. Consequently if we observe a larger proportion of immigrant crimes between these years than the above figures for the census years show, it is reasonable to attribute this mainly to their numbers. The percentages of the immigrant crime rose from 39.8 in 1911 to 45.6 in 1914, then declined to 36.2 in 1919, which would appear to strengthen materially the argument that the crime rate is influenced by immigrant, or floating population.

rate must be obtained to do this. But before calculating per capita figures it is necessary to consider the volume of population at each age group in order to obtain the total population size index. Crude per capita figures are inadequate.

TABLE VII

ESTIMATE OF POPULATION AT THE DIFFERENT AGE GROUPS—MALES

(In thousands)

Year	7–15	16–20	21–39	40 and over
1891	510	254	690	570
1901	544	266	792	677
1902	556	275	821	700
1903	568	282	856	722
1904	579	290	897	746
1905	591	298	940	770
1906	603	305	989	794
1907	615	316	1,031	818
1908	627	324	1,085	843
1909	638	331	1,143	869
1910	650	339	1,193	893
1911	662	347	1,259	921
1912	681	356	1,337	948
1913	700	365	1,422	975
1914	719	375	1,511	1,002
1915	738	372	1,380	1,030
1916	757	371	1,287	1,059
1917	776	373	1,231	1,088
1918	796	376	1,212	1,117
1919	815	381	1,231	1,146
1920	835	386	1,287	1,177
1921	853	393	1,312	1,207
1922	863	397	1,326	1,238
1923	878	403	1,344	1,269
1924	893	409	1,354	1,301
1925	909	416	1,372	1,333
1926	932	424	1,391	1,366
1927	956	434	1,410	1,399
1928	980	445	1,431	1,432
1929	1,004	456	1,450	1,460

For Table VII the populations have been estimated for each intercensal year. Corrections have been made for the varying numbers of immigrant arrivals and the absence of the 400,000 men during the War. The male population, therefore, cleared of these influences, is given for the four age groups for the year 1891 and for each year from 1901 to 1929. The figures are given in thousands.

Weighting these population figures by the percentages of crime for each age group as shown in Tables II and III gives an index of population from the point of view of crime, as affected by age composition, as shown in Table VIII. By dividing the gross crime index by the index just obtained we have the real crime rate, in the last column. In other words a per capita index, cleared of disturbing population elements, showing the true trend of crime.

This true index of crime rate is vastly different from the gross index. Still there is an upward trend and notable peaks and depressions around

the war years. Is this trend and are these peaks significant apart from population, or is there some population size influence left?

There is yet another population element to be investigated in answer to the above, and that is population density or urbanization.

TABLE VIII

INDEX OF POPULATION WEIGHTED FOR AGE-CRIME COMPOSITION, INDEX OF GROSS CRIME, AND INDEX OF CRIME RATE

Year	Index of population from point of view of crime	Index of gross crime	Index of crime rate
1901	100.0	100.0	100.0
1902	103.5	100.2	96.8
1903	107.3	114.5	106.7
1904	111.6	119.2	106.8
1905	115.7	135.4	117.0
1906	120.3	145.4	120.9
1907	124.9	163.4	130.8
1908	130.1	203.8	156.6
1909	137.2	208.7	152.1
1910	140.5	205.3	146.1
1911	146.8	225.3	153.5
1912	154.2	278.2	180.4
1913	161.9	327.6	202.3
1914	170.1	392.4	230.7
1915	161.7	370.0	228.8
1916	155.9	284.4	182.4
1917	153.0	241.2	157.6
1918	153.0	273.2	178.6
1919	156.1	300.2	193.0
1920	161.6	306.6	189.8
1921	165.0	329.2	199.5
1922	167.3	333.3	199.2
1923	169.9	325.4	191.5
1924	171.0	354.0	207.0
1925	174.9	370.9	212.1
1926	178.1	378.4	212.5
1927	181.3	404.3	223.0
1928	184.7	456.9	247.4
1929	187.9	500.3	266.3

It was found that in the judicial districts containing large cities such as Montreal, Toronto and Hamilton, the crime rate averages approximately 500 to the 100,000 population, whereas in the least densely populated districts the rate averages about 90. This fact furnishes unmistakable evidence of the influence of population density on the crime rate.

Computations show that the urban population of Canada has increased at a faster rate than the rural. The proportion of urban population, on the basis of centers of 5,000 and upwards, increased from 24.7 per cent in 1901 to 36.5 per cent in 1921. Taking this proportionate, rather than the direct increase, we obtain the index shown in the second column of Table IX.

It could be shown from Table I that crime increases as the square of the population.

The index of the actual crime rate shows that the upward trend is reduced to slightly over fifty per cent of the gross trend; that is, from

TABLE IX

CRIME RATE CLEARED OF THE INFLUENCE OF URBANIZATION OR POPULATION DENSITY

Year	Index of crime rate	Index of urban population increase	Index of crime cleared of population density influence
1901	100.0	100.0	100.0
1902	96.8	103.4	93.6
1903	106.7	106.5	100.1
1904	106.8	109.8	97.3
1905	117.0	112.9	103.7
1906	120.9	116.2	104.1
1907	130.8	119.4	107.6
1908	156.6	122.7	127.6
1909	152.1	125.9	120.8
1910	146.1	129.1	113.1
1911	153.5	132.4	115.9
1912	180.4	134.0	134.6
1913	202.3	135.6	149.2
1914	230.7	136.8	168.6
1915	228.8	136.8	167.2
1916	182.4	136.8	133.4
1917	157.6	136.8	115.2
1918	178.6	142.1	126.3
1919	193.0	144.5	133.7
1920	189.8	146.1	129.9
1921	199.5	147.7	135.1
1922	199.2	149.7	133.1
1923	191.5	152.2	125.8
1924	207.0	154.2	134.2
1925	212.1	156.7	135.3
1926	212.5	158.7	135.2
1927	223.0	160.8	138.6
1928	247.4	163.1	151.7
1929	266.3	165.2	161.2

500.3 to 266.3 during the period. Now by dividing this index of crime rate by the urban population index we obtain the trend cleared of the influence of population density.

The significance of these deductions is clearly illustrated in the accompanying chart, which shows, first, the trend of crime by gross figures; second, the actual trend when cleared of disturbing population elements; and third, the trend after correcting for population density. This last curve is of particular interest, revealing that, notwithstanding it is cleared of all known physical influences, there are still peaks and depressions, particularly around the war years. What caused this great disturbance in the crime trend at that time? That which is left of the upward peak at 1914, as shown in the last curve, must be due to some economic condition culminating with the outbreak of the Great War.

We might recall here what we said in regard to the floating population. Again there is the question of unemployment. Unfortunately we have no data upon which to base any deductions in this connection. It is known, however, that unemployment was a very live problem prior to 1914, which was dissipated by the war's absorption of a large number of adult males. Is the upward trend of the last few years attributable to the same cause? If figures respecting unemployment were available

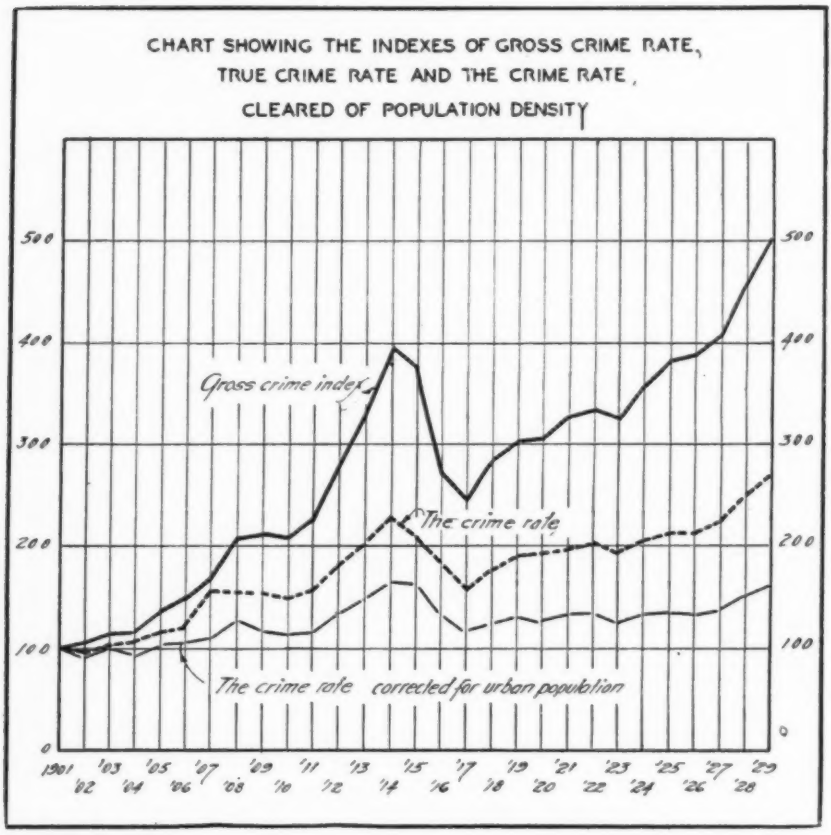


CHART SHOWING THE INDEXES OF GROSS CRIME RATE,
TRUE CRIME RATE AND THE CRIME RATE,
CLEARED OF POPULATION DENSITY
500
400
300
200
100
0
Gross crime index
The crime rate
The crime rate corrected for urban population
1901 '02 '03 '04 '05 '06 '07 '08 '09 '10 '11 '12 '13 '14 '15 '16 '17 '18 '19 '20 '21 '22 '23 '24 '25 '26 '27 '28 '29

no doubt it could be shown that a correlation exists in connection with these two phenomena.

Apart from the fact that it is impossible, with the data at hand, to level the curve it is abundantly evident that the crime rate is materially affected by the growth and urbanization of the population.

ANALYSIS OF THE SPURIOUS EFFECT OF HIGH INTERCORRELATION OF INDEPENDENT VARIABLES ON REGRESSION AND CORRELATION COEFFICIENTS

By Henry I. Richards

When two or more perfectly intercorrelated independent variables are correlated with a dependent variable it is rather generally supposed that spurious results will be obtained. The statement is made in volume two of *Research Methods and Procedure in Agricultural Economics* (page 236) that "if an attempt were made to correlate the value of farms with three factors, namely, (a) the percentage of land in corn, (b) the percentage of land in wheat, and (c) the percentage of land in all other uses, it would be impossible to solve the problem or else it would give a spurious result, because the three factors, (a), (b), and (c), would add to exactly 100 per cent in each individual case, and after variations in (a) and (b) had been held constant by statistical means there would not be any room left for variations in (c). Only by dropping out one of the factors, say (c), would significant results be secured."

This statement seems to imply that spurious results are obtained when the intercorrelation of two or more independent factors is perfect, due to some cause that does not affect the results obtained when the intercorrelation is less than one. If this implication were true, the problem would have little practical significance to most experienced statisticians. But if the same causes operate to give spurious results also when the intercorrelation is high but not perfect, the problem becomes of much more general and practical significance.

There are two possible causes of the above type of spurious results, one involving the algebraic solution or determination of coefficients of correlation and regression, and the other involving the accuracy of the arithmetic solution of the algebraic formulae. An analysis of the algebraic formulae should make clear whether or not spurious results of this kind are obtained only when the intercorrelation is perfect. Further analysis can then be made of the possible errors due to the arithmetic solution of these formulae.

The formula for obtaining the multiple correlation coefficient given by Yule for such a problem is

$$1-R^2_{1\cdot 234\ldots n}=(1-r^2_{12})\ (1-r^2_{13\cdot 2})\ (1-r^2_{14\cdot 23})\ \ldots\ (1-r^2_{1n-23\ldots n-1})$$

and the one for computing the partial correlation coefficient

$$r_{14\cdot 23}=\frac{r_{14}-r_{1\cdot 23}\cdot r_{4\cdot 23}}{(1-r^2_{1\cdot 23})^{\frac{1}{2}}(1-r^2_{4\cdot 23})^{\frac{1}{2}}}.$$

If a dependent variable (X_1) is correlated with independent variables X_2, X_3, and X_4 the sum of which equals 100 in each equation, or, in other words, which are perfectly intercorrelated, it is easy to see that the results obtained from the first equation would be the same whether X_4, for example, was included or omitted. The factors $(1-r^2_{12})$ and $(1-r^2_{13\cdot 2})$ would be the same in both cases since X_4 is not included in either one. The factor $(1-r^2_{14\cdot 23})$ would, however, be equal to one whenever $r_{4\cdot 23}$ equaled 1.00. This can be shown by analysis of the equation for determining partial correlation coefficients. Whenever there is perfect correlation between X_4 and the independent variables X_2 and X_3, the factor $(1-r^2_{4\cdot 23})$ would equal 0. This would make the denominator equal to 0. The numerator would also equal 0, since $r_{4\cdot 23}$ would equal one and $r_{1\cdot 23}$ would equal r_{14}. The partial correlation coefficient for $r_{14\cdot 23}$ in the first equation, would therefore equal 0.[1] The equation for determining the coefficient of multiple correlation in such cases would be

$$1-R^2_{1\cdot 234}=(1-r^2_{12})\ (1-r^2_{13\cdot 2})\ (1-0).$$

The net regression coefficients would also be unaffected by the inclusion of the variable X_4 if all computations can be accurately carried out. The usual method of computing these coefficients may be summarized as follows.

The equation for determining the coefficient of net regression of X_1 on X_4 in the above problem according to Yule is

$$b_{14\cdot 23}=r_{14\cdot 23}\quad\frac{\sigma_{1\cdot 23}}{\eta\sigma_{4\cdot 23}}.$$

The $r_{14\cdot 23}$ in this equation equals 0 whenever $r_{4\cdot 23}$ equals one as shown above. The net regression coefficient $b_{14\cdot 23}$ would therefore equal 0 when $r_{4\cdot 23}$ equaled one.

The net regression coefficient $b_{13\cdot 24}$ is usually computed in the back solution of the Doolittle method from the equation

$$b_{13\cdot 24}=b_{12\cdot 3}-b_{14\cdot 23}\cdot b_{43\cdot 2}.$$

[1] This statement may be proved by differentiating the equation $r_{14\cdot 23}=\frac{r_{14}-r_{1\cdot 23}\,r_{4\cdot 23}}{\sqrt{1-r^2_{1\cdot 23}}\cdot\sqrt{1-r^2_{4\cdot 23}}}$ with respect to $r_{4\cdot 23}$ approaching a limit of ± 1. $\underset{r_{4\cdot 23}}{\text{Limit}}=\pm 1\dfrac{-r_{1\cdot 23}}{\frac{1}{2}\frac{-2r_{4\cdot 23}}{\sqrt{1-r^2_{4\cdot 23}}}\sqrt{1-r^2_{1\cdot 23}}}=\dfrac{r_{1\cdot 23}\sqrt{1-r^2_{4\cdot 23}}}{r_{4\cdot 23}\sqrt{1-r^2_{1\cdot 23}}}$.

When $r_{4\cdot 23}$ is ± 1 the value of this fraction is 0. Therefore the limiting value of $r_{14\cdot 23}$ as $r_{4\cdot 23}$ approaches ± 1 is 0.

Since $b_{14\cdot23}\cdot b_{43\cdot2}$ would equal 0 when $r_{4\cdot23}$ equaled one, as shown above, $b_{13\cdot24}$ would then be equal to $b_{12\cdot3}$.

In the same manner it may be shown that $b_{12\cdot34}$ is computed from the equation

$$b_{12\cdot34}=b_{12}-b_{14\cdot23}.b_{43}-b_{13\cdot24}.b_{32}.$$

In this equation $b_{14\cdot23}.b_{43}$ equals 0 when $r_{4\cdot23}$ equals one, and since $b_{13\cdot24}$ has been shown to equal $b_{12\cdot3}$ in this case, the equation may be written

$$b_{12\cdot34}=b_{12}-b_{12\cdot3}.b_{32}.$$

These equations are the same as they would have been with the independent variable X_4 omitted.

In other words, the algebraic formulae indicate that the same coefficient of multiple correlation and regression would be obtained by including an independent variable such as X_4 that is perfectly correlated with one or more of the other independent variables, as would be obtained by omitting it. The inclusion of such a variable would simply be unnecessary, judging from the algebraic solution of this problem.

However, the partial correlation coefficients for the independent variables that are perfectly correlated would all be 0 as shown for $r_{14\cdot23}$ above. This result illustrates most clearly that the elements in an independent variable that are common to other independent variables included in the analysis are not reflected or represented in the coefficients of partial correlation with the dependent variable. But the partial correlation coefficients between the dependent variable and other independent variables would not be affected by the presence of perfectly intercorrelated, independent variables in the analysis. For example $R_{1\cdot234\ \ldots\ n}$ has been shown to be the same algebraically regardless of the fact that $r_{2\cdot34\ \ldots\ n}$ may be equal to one as shown above. Therefore since

$$r_{15\cdot234\ \ldots\ n}=\frac{r_{15}-r_{1\cdot234\ \ldots\ n}\cdot r_{5n}}{(1-r^2_{1\cdot234\ \ldots\ n})^{\frac{1}{2}}(1-r^2_{5\cdot234\ \ldots\ n})^{\frac{1}{2}}}$$

and none of the coefficients of correlation are affected by the fact that $r_{2\cdot34}$ equals one, $r_{15\cdot234\ \ldots\ n}$ will not be affected.

Further proof of these conclusions is presented in the following analysis of a special problem. In this problem the X_3 plus X_4 series equaled 100 in each equation. There were ten observations for each variable, which made it possible to determine the averages accurately without dropping any fractions.

A third independent variable X_2 was included in this problem in order to show the effect of perfect intercorrelation between two or

more independent variables on the net regression and correlation coefficients of other variables included in the same correlation analysis.

A multiple correlation analysis has also been carried through with three independent variables totaling 100 for each observation equation. The results were the same in principle as shown in Table I.

TABLE I

EFFECT OF INDEPENDENT FACTORS TOTALING 100 PER CENT ON COEFFICIENTS OF CORRELATION AND REGRESSION (TEN OBSERVATIONS)

(*Correlation Analysis* by the Wallace and Snedecor Method)

	X_2	X_3 (per cent of X_4)	X_4 (per cent of X_2)	X_1
Sums	601	400	600	763
Means	60.1	40	60	76.3
$\Sigma(x^2_2)$ 3996.9		$\Sigma(x_2x_3)$ −2047	$\Sigma(x_2x_4)$ 2047	$\Sigma(x_2x_1)$ −2670.3
		$\Sigma(x^2_3)$ 1728	$\Sigma(x_3x_4)$ 1728	$\Sigma(x_3x_1)$ 1894
			$\Sigma(x^2_4)$ 1728	$\Sigma(x_4x_1)$ −1894
				$\Sigma(x^2_1)$ 2412.1
$1.0000(r_{22})$	$-.7789(r_{23})$	$+.7789(r_{24})$		$-.8600(r_{12})$
	$+.7789$	$-.7789$		$+.8600$
	$+1.0000(r_{33})$	$-1.0000(r_{34})$		$+.9277(r_{13})$
	$-.6067$	$+.6067$		$-.6699$
	$+.3933(1-r^2_{23})$	$-.3933$		$+.2578$
	-1.0000	$+1.0000(\beta_{43.2})$		$-.6556(\beta_{13.2})$
		$+1.0000(r_{44})$		$-.9277(r_{14})$
		$-.6067$		$+.6699$
		$-.3933$		$+.2578$
		$.0000(1-R^2_{4.23})$		$.0000(\beta_{14.23})$
		BACK SOLUTION		
$\beta_{14.23}$		0		0
$\beta_{13.24}$		$+.6555801$ 0		$+.6555801$
$\beta_{12.34}$	$-.3493702$	$+.5106344$ 0		$-.8600046$
		$R_{1.234}=\sqrt{.9086456985}$		

This method of determining correlation and regression coefficients has been used because the intercorrelation of the different variables is shown clearly at each step in the process. For instance, in the last block of column X_4 we have the coefficient of alienation or one minus the square of the multiple correlation of X_4 with X_2 and X_3. If a variable (X_5) was added, after the X_4 and before X_1, the last block of the (X_5) column would show the factor $(1-R^2_{5\cdot 432})$. The betas obtained by this method are simply regression coefficients expressed in terms of standard measure. For example, $b_{12\cdot 34}$ is equal to $\beta_{12\cdot 34}\frac{\sigma x_1}{\sigma x_2}$.

For an explanation of this method see *Statistical Method* by Truman L.

Kelley, page 282, or *Correlation and Machine Calculation* by H. M. Wallace and George W. Snedecor.

It should be noted that the sum of the squares of the deviations of X_3 and X_4 from their respective averages and the sum of deviations x_3 times x_4 are all equal. The product of deviations x_2 times x_3 is also equal to x_2 times x_4. The arithmetical calculation of simple coefficients of correlation therefore results in a r_{34} equal to minus one and the same coefficient of correlation for r_{23} as for r_{24}, also the same for r_{13} as for r_{14}. Carrying the calculations still farther results in 0 for $\beta_{14\cdot23}$, which agrees with the algebraic analysis above. $\beta_{14\cdot23}\cdot\beta_{43\cdot2}$ and $\beta_{14\cdot23}\cdot\beta_{42}$ also equal 0.

Final results for this problem, therefore, show that the regression and multiple correlation coefficients between X_1 and X_2 and X_3 are the same whether X_4 is included or omitted.

The results of this analysis are of special interest in view of the statement quoted at the beginning of this article and of another by Elmer J. Working in the same publication stating that "Since the correlation r_{23} (the correlation between two independent variables) is equal to 1.00000, the normal equations cannot be solved. If the work is not carried out with extreme accuracy and log P+log V does not exactly equal log T plus a constant, the equations can be solved. The solutions are without meaning, however, because their values depend on the errors and are very greatly influenced by very slight errors in the first order r's. This whole situation is due, of course, to the perfect correlation which exists between each two of the three variables." The above analysis, however, has shown that accurate coefficients of multiple correlation and regression can be obtained when the independent variables are perfectly intercorrelated if there are no errors in the calculations. In fact, if the calculations necessary to obtain the coefficients of regression or multiple correlation are carried through in algebra and the necessary values substituted in the final equations, the same results would always be obtained by the inclusion or omission of an independent variable perfectly correlated with one or more of the other independent variables included.

It remains to be shown, however, what effect small errors in the calculation of averages, product moments, first order r's, etc., would have on the final results obtained by the usual method. In the above problem, ten observation equations were taken in order that the averages would be accurately determined. If the last observation equation in the above example is dropped, and the averages carried to four decimal places dropping the remaining fractions if less than one-half and adding if more than one-half, the product moments of the devia-

tions would be as shown in Table II. The only significant difference in this set of product moments and the preceding ones is that $\Sigma(x_2x_4)$ equals 2040.5 while $\Sigma(x_2x_3)$ equals -2040.4, a difference of 0.1, whereas in the previous problem the $\Sigma(x_2x_4)=\Sigma(x_2x_3)$.

TABLE II

EFFECT OF INDEPENDENT FACTORS TOTALING 100 PER CENT ON COEFFICIENTS OF CORRELATION AND REGRESSION (NINE OBSERVATIONS)

(*Correlation Analysis* by the Wallace and Snedecor Method)

	X_2	X_3	X_4	X_1
Sum	535	361	539	693
Means	59.4444	40.1111	59.8889	77.0000
$\Sigma(x_2^2)$ 3958.2	$\Sigma(x_2x_3)-2040.4$	$\Sigma(x_2x_4)$ 2040.5	$\Sigma(x_2x_1)-2629.0$	
	$\Sigma(x_3^2)$ 1726.9	$\Sigma(x_3x_4)-1726.9$	$\Sigma(x_3x_1)$ 1887.0	
		$\Sigma(x_4^2)$ -1726.9	$\Sigma(x_4x_1)$ 1887.0	
			$\Sigma(x_1^2)$ 2368.0	
1.00000	$-.780428(r_{23})$	$+.780466(r_{24})$	$-.858719(r_{21})$	
-1.00000	$+.780428$	$-.780466$	$+.858719$	
	$+1.000000$	$-1.000000(r_{34})$	$+.933141(r_{31})$	
	$-.609068$	$+.609098$	$-.670168$	
	$+.390932(1-r^2_{23})$	$-.390902$	$+.262973$	
	1.000000	$+.999923(\beta_{43\cdot2})$	$-.672682(\beta_{13\cdot2})$	
		$+1.000000$	$-.933141(r_{41})$	
		$-.609127$	$+.670201$	
		$-.390872$	$+.262953$	
		$+.000001(1-R^2_{4\cdot23})$	$+.000013$	
		1.000000	$-13.000000(\beta_{14\cdot23})$	
		BACK SOLUTION		
$\beta_{14\cdot23}$		$+13.000000$	$+13.000000$	
$\beta_{13\cdot24}$	$+13.671681$	$+12.998999$	$+.672682$	
$\beta_{12\cdot34}$ $-.335014$	$+10.669763$	-10.146058	$-.858719$	
		$R_{1\cdot234}=\sqrt{.9562719}$		

These results may be compared with similar calculations for the correlation of X_1 with only X_2 and X_3 variables. The coefficient of multiple correlation is $R_{1\cdot234}=.9562719$ for the first and $R_{1\cdot23}=.9561877$ for the second. This difference is negligible.

The regression equation, however, is changed a great deal by the small errors due to dropping or increasing small fractions in calculating the product moments about the mean and the first order r's. The two regression equations in terms of the original series with X_4 included (I) and omitted (II) are as follows:

I.	$X_1 = -.259122X_2$	$+16.009545X_3$	$+15.223007X_4$	-1461.4463
II.	$X_1 = -.258136X_2+$	$.787711X_3+$		60.7487
Difference	.000986	15.221834	15.223007	−1400.6976

The net regression coefficient of X_1 on X_3 is much higher when the X_4 variable is included than when it is omitted. The increase, however, is practically equal to the net regression of X_1 on X_4. The net regression of X_1 on X_2 is practically the same whether X_4 is included or omitted, but the constant is reduced to a large negative value. In other words, the increase in coefficients of net regression of X_1 on X_3 and X_4 when both are included is offset by a decrease in the constant. This is easily explained in this problem by the fact that since X_3+X_4 always equals 100 the *same* increase in the net regression coefficients for both variables would act as a constant.

Furthermore, since the computed intercorrelation of X_4 with X_3 is equal to .999925, almost any number could be substituted in the above analysis for $\beta_{14\cdot23}$ without affecting the coefficient of multiple correlation. The values of $\beta_{14\cdot23}$ that might be obtained in such a problem would range from 0, the correct value obtained when there are no errors, to infinity when the computed value of $1-R^2_{4\cdot23}$ equals 0 and the computed value of $(\beta_{14\cdot23})\ (1-R^2_{4\cdot32})$ equals more than 0. In the above illustration these values were .000001 and .000013 respectively.

Since the second factor $(\beta_{14\cdot23})\ (1-R^2_{4\cdot32})$ is divided by the first $(1-R^2_{4\cdot23})$ to obtain $\beta_{14\cdot23}$ the influence of small errors in determining these factors on the value of $\beta_{14\cdot23}$ must increase as the intercorrelation of the independent variables increases. The effect of an error in the second factor only of $\pm.0003$ on the value of $\beta_{14\cdot23}$ for various degrees of intercorrelation in the symbols of our problem would be as follows:

$R_{4\cdot23}$	$1-R^2_{4\cdot23}$	Range of error in $\beta_{14\cdot23}$
.995	.009975	.0602
.99	.0199	.0302
.98	.0396	.0152
.97	.0591	.0102
.96	.0784	.0076
.95	.0975	.0062

Of course small errors would also occur in computing $1-R^2_{4\cdot23}$ and these would increase the possible range of effect on the coefficients of net regression.

Any errors made in computing $\beta_{14\cdot23}$ would also cause errors in com-

puting $\beta_{13\cdot24}$ and $\beta_{12\cdot34}$. The entire net regression equation would be changed. In order to determine the degree of change in the net regression coefficients that would be caused by an error of $\pm.0003$ as described above, with various high degrees of intercorrelation, the above analysis was carried through with various slight changes in the independent variable X_4. The results may be summarized as follows:

TABLE III

NET REGRESSION COEFFICIENTS

$R_{4\cdot23}$	Assumed error in $\beta_{14\cdot23}(1-R^2_{4\cdot23})$	$b_{12\cdot34}$	$b_{13\cdot24}$	$b_{14\cdot23}$	K_1	$R_{1\cdot234}$
.999999	+.0000013*	− .2591	+16.0095	+15.2230	−1461.4463	.9562
	0	− .2581	+ .7877	0	+ 60.7487	.9561
.999965	+.0003	− .5345	+ 1.0076	− .2654	+ 95.7866	.9573
	0					.9573
	−.0003	− .7487	+ 1.2061	− .0378	+ 120.0036	.9573
.9578	+.0003	− .9116	+ 1.2305	+ .1913	+ 97.6534	.9585
	0					.9585
	−.0003	− .9062	+ 1.2308	+ .1833	+ 97.5861	.9584
.97443	+.0003	−1.3713	+ 1.4768	+ .7250	+ 100.6304	.9718
	0					.9716
	−.0003	−1.3558	+ 1.4704	+ .7059	+ 100.5091	.9714
.8606	+.0003	−1.0077	+ 1.2583	+ .2979	+ 98.5981	.9719
	0					.9719
	−.0003	−1.0062	+ 1.2580	+ .2958	+ 98.5882	.9718

* Actual error obtained in computations.

These results clearly demonstrate that small unavoidable errors of calculation may have an important effect on the coefficients of regression when the intercorrelation is high as well as when it is perfect. The effect of such errors on the size of regression coefficients, however, decreases very rapidly as the intercorrelation of the independent variables declines, being of little significance when the intercorrelation is less than .95. It must also be remembered that an error of $\pm.0003$ in computing $\beta_{14\cdot23}(1-R^2_{4\cdot23})$ is an extreme one. The usual errors would be around $\pm.0001$ or $\pm.0002$. However, when the intercorrelation of independent variables is very high a small error in computing $(1-R^2_{4\cdot23})$ would have considerable effect on the regression coefficients.

The coefficient of multiple correlation, however, is not materially affected by such small unavoidable errors of calculation when the intercorrelation is low, high or perfect. The stability of this measure of relationship is shown in the last column of the above table.

We may therefore conclude that the inclusion of an independent variable that is perfectly correlated with the other independent variables included will not materially change the coefficient of multiple correlation but will make the coefficients of partial correlation 0 for all

independent variables that are perfectly intercorrelated if there are no errors in calculation, and will result in extreme changes in the size of net regression coefficients if there are any errors in calculation. Spurious coefficients of net regression, due to small errors of calculation, unavoidable by the usual methods, are not limited to problems in which the intercorrelation of the independent variables is perfect. When the intercorrelation is high, important changes in the coefficients of net regression may also be caused. These errors, however, may be avoided entirely by working out algebraic equations of net regression and then substituting the computed values.

A COMPARISON OF ACTUAL AND NORMAL WORKING TIME IN STANDARD MACHINE-TOOL OCCUPATIONS

By H. La Rue Frain, *University of Pennsylvania*

The assumption of normal time plays an important part in wage analyses and comparisons. In an earlier article[1] certain observations were made concerning this assumption. The purpose of the present article is to summarize the findings of several sets of data and draw certain conclusions therefrom.

The expression "normal time" is used in various ways. In one sense it refers to the number of hours constituting the full-time week. Thus it may be said that the normal time of a firm is, say, 50 hours per week. When the expression is used in this way it frequently carries with it the implication that actual working time corresponds with the normal time. This implication is likely to be encountered when comparisons are made of full-time weekly earnings. Unless actual time approximates the normal time the significance of full-time earnings is very limited, since they would reflect only potential earnings without giving any indication of the actual, or "take home," money passing into the hands of the employees. But if actual time does correspond fairly well with normal time, then the usefulness of the figure for full-time earnings is much enhanced.

Three major points will be considered in this paper. First, how do actual and normal time compare in each of two weekly periods? Second, if there is similarity does this warrant the inference that most of the employees actually worked normal time? Third, how do actual and normal time compare as between firms?

The answers to these questions come from four sets of data involving standard machine-tool occupations in the Philadelphia metal manufacturing area. Attention will center on two surveys each covering a period of a week. The one was made during April, 1927, and the other during October, 1929. Both April and October are months of seasonal activity, but the general business conditions in 1929 were better than in 1927. In the earlier period 43 firms coöperated and reported information for 1,456 men, while 49 firms, with 1,870 men, furnished the data in the later period. Only 28 identical firms reported in both periods, but these firms account for about 63 per cent of all the men reported in 1927, and 52 per cent in 1929. Incidental attention will be given to two other surveys of a somewhat different nature. Ten firms in 1925

[1] This Journal, September, 1929.

and twelve in 1926 coöperated in furnishing information as to the actual working time *week by week* for employees in the designated occupations. Thus it is possible to contrast, in certain regards, weekly data for 1927 and 1929 with yearly data for 1925 and 1926.

The analysis is complicated somewhat by the fact that normal time is not uniform as between the firms for the selected occupations. In fact it varies from 44 to 55 hours per week in both 1927 and 1929, with two firms reporting night shifts of 60 hours in 1929. Here then is a rather appreciable spread in normal time, amounting to about eleven hours for day workers.[1] In addition to the similarity in the limits within which variation occurs in both years there is similarity in the average normal time for all workers and similarity in the average for all firms; the former being 50.8 and 50.5 hours in 1927 and 1929 respectively, and the latter being 51.1 and 51.4. The significance of these averages is increased by virtue of their approximating median hours in each case.

To the question of whether or not, in each of the weekly periods, actual and normal time correspond in the aggregate, the answer is that the similarity is rather close, especially for all the machine-tool operators as a group. From Table I it appears that for the combined occu-

TABLE I

COMPARISON OF AVERAGE ACTUAL AND AVERAGE NORMAL TIME BY OCCUPATIONS, 1927 AND 1929

Occupation	1927			1929		
	Average actual hours	Average normal hours	Per cent actual of normal	Average actual hours	Average normal hours	Per cent actual of normal
Boring mill operating	51.1	53.2	96.1	54.8	51.2	107.0
Drill press operating	50.8	49.7	102.2	50.6	49.9	101.4
Engine lathe operating	50.5	51.9	97.3	52.0	50.5	103.0
Milling machine operating	50.2	49.5	101.4	53.0	48.9	108.4
Planer operating	52.5	52.4	100.2	54.5	50.9	107.1
Screw machine operating	49.0	49.1	99.8	50.2	49.6	101.2
Turret lathe operating	49.8	51.4	96.9	49.4	50.9	97.1
Combined occupations	50.3	50.8	99.0	51.9	50.5	102.8

pation the actual time averaged 50.3 hours as against 50.8 for normal time in 1927, and the corresponding averages were 51.9 and 50.5 in 1929. The difference between the averages for most of the individual occupations varies from about 0.6 to 3.6 hours.

Expressed differently, actual time for all the occupations combined was 99.0 per cent of normal in 1927 and 102.8 per cent in 1929. With the individual occupations the variation runs from 95.3 to 102.2 per cent in the former and from 97.0 to 108.4 per cent in the latter period.

[1] The distribution of normal hours in 1929 was similar to that for 1927 as shown by Table I in the article previously referred to.

But even such similarity as exists between actual and normal time when the occupations are combined does not warrant the inference that most of the men actually worked the normal time of their firms during either of the weeks surveyed. About one-half (52.2 per cent) of all the men in 1927 worked normal time as against about one-third (33.5 per cent) in 1929. This leaves a considerable proportion of men unaccounted for each year. Short time accounts for slightly over one-fourth each year (28.4 per cent in 1927 and 28.7 per cent in 1929), while over time accounts for about one-fifth (19.4 per cent) in the earlier and about two-fifths (37.8 per cent) in the later period. These proportions for the combined occupations appear to be fairly representative of the individual occupations as may be seen by Table II.

TABLE II

NUMBER AND PER CENT OF STANDARD MACHINE-TOOL OPERATORS IN SPECIFIED OCCUPATIONS WHO WORKED UNDER-NORMAL, NORMAL AND OVER-NORMAL HOURS PER WEEK, 1927 AND 1929

Occupation	Number				Per cent			
	Under normal	Normal	Over normal	Total	Under normal	Normal	Over normal	Total
	1927							
Boring mill operating	61	57	31	149	40.9	38.3	20.8	100.0
Drill press operating	48	132	65	245	19.6	53.9	26.5	100.0
Engine lathe operating	137	187	88	412	33.2	45.4	21.4	100.0
Milling machine operating	47	116	44	207	22.7	56.0	21.3	100.0
Planer operating	16	35	7	58	27.6	60.3	12.1	100.0
Screw machine operating	65	170	25	260	25.0	65.4	9.6	100.0
Turret lathe operating	39	63	23	125	31.2	50.4	18.4	100.0
Combined occupations	413	760	283	1456	28.4	52.2	19.4	100.0
	1929							
Boring mill operating	64	67	107	238	26.9	28.2	44.9	100.0
Drill press operating	103	122	114	339	30.4	36.0	33.6	100.0
Engine lathe operating	158	181	171	510	31.0	35.5	33.5	100.0
Milling machine operating	63	73	134	270	23.3	27.0	49.7	100.0
Planer operating	22	26	43	91	24.2	28.6	47.2	100.0
Screw machine operating	70	82	88	240	29.2	34.2	36.6	100.0
Turret lathe operating	57	75	50	182	31.3	41.2	27.5	100.0
Combined occupations	537	626	707	1870	28.7	33.5	37.8	100.0

On the basis of the yearly data of 1925 and 1926 a much smaller proportion of men worked normal time and a much larger proportion worked short time than in either of the weekly periods. If only the full-year men are considered, or those working 49 weeks or more each year, then only 9 per cent of the 248 men in 1925 and of the 403 in 1926 worked an average number of hours per week equivalent to the normal time of their firms. The bulk of the men (between 71 and 77

per cent) averaged less than normal time, with between 14 and 20 per cent averaging more than normal time.

At least two circumstances contribute to this difference in results as between weekly and yearly data. First, the weekly surveys covered months in which seasonal activity is usually high, while yearly data, on the other hand, include the less favorable off-season months. In the second place, neither of the weekly periods include inventory time when many firms are nearly, if not completely, idle, although such periods are included in the yearly data. While these circumstances suggest unreliability of weekly data as an index to yearly working time, they do not detract from the importance of weekly data as indicating what is likely to be close to the most favorable weekly situation throughout the year so far as working opportunity is concerned.

While short time may arise from a number of causes, there is only one on which data are available. If an employee were engaged at any other time than at the beginning of a pay period, the date of employment in itself would cause short time. But only four or five men were reported as having length of service of less than a week in 1929, and if all those with service records of less than a month were included the number would not be much larger. It appears, therefore, that in the year of more active business an insignificant proportion of men could have had short time by virtue of their date of original employment. This leaves short time to be accounted for by causes within the control of the worker or of the management.

Even more important than the number of short-time and of over-time men is the degree to which their actual time varied from their normal time. It is interesting to notice that the average actual time for each group is about the same in both 1927 and 1929. Short-time men averaged 43.2 and 42.9 hours in the respective years, while over-time workers averaged 61.0 and 59.3 hours. And these averages are fairly representative of those for the individual occupations as may be seen by Table III. With these occupations short time ranged from 41.4 to 45.6 hours in 1927 and from 40.6 to 46.7 in 1929, while over-time hours in the respective years ranged from 60.1 to 64.6 [1] and from 57.6 to 62.5.

When these averages for actual time are related to the corresponding averages for normal time, then the actual hours for all machine-tool operators working short time averaged about 83.0 per cent of normal time in 1927 and 84.1 per cent in 1929, while for the men working over time the actual hours averaged 118.3 and 119.5 per cent in the respective years. Thus it appears that not only is the degree of either short

[1] Excepting planer operating.

TABLE III

COMPARISON OF AVERAGE ACTUAL AND AVERAGE NORMAL TIME IN 1927 AND 1929 FOR UNDER-NORMAL AND OVER-NORMAL TIME MEN IN SPECIFIED OCCUPATIONS

	Average actual hours		Average normal hours		Per cent actual of normal	
	1927	1929	1927	1929	1927	1929
	Under-normal time men					
Boring mill operating	43.6	46.4	54.0	51.8	80.7	89.4
Drill press operating	41.4	42.8	50.9	50.2	81.3	85.3
Engine lathe operating	42.9	43.7	53.0	52.2	80.9	83.7
Milling machine operating	43.1	41.8	49.9	49.5	86.4	84.4
Planer operating	45.2	42.9	53.3	51.5	84.8	83.3
Screw machine operating	45.6	40.6	49.9	49.3	91.4	82.4
Turret lathe operating	39.7	40.7	51.1	51.1	77.6	79.6
Combined occupations	43.1	42.9	51.9	51.0	83.0	84.1
	Over-normal time men					
Boring mill operating	64.6	62.0	54.4	51.2	118.8	121.1
Drill press operating	60.1	57.6	49.0	49.9	122.7	115.4
Engine lathe operating	61.4	60.3	52.4	51.4	117.2	117.3
Milling machine operating	58.5	59.0	47.9	49.8	122.1	118.5
Planer operating	69.2	62.5	50.3	50.9	137.6	122.8
Screw machine operating	57.5	56.4	48.2	49.6	119.3	113.7
Turret lathe operating	63.4	56.6	52.5	50.9	120.8	111.2
Combined occupations	61.0	59.3	50.7	50.5	120.3	117.4

time or of over time about the same both years, but that short time averages about as much below normal as over time averages above it. And the percentages for the combined occupations are fairly representative of those for most of the individual occupations, as is shown by Table III. Short-time hours averaged from 77.6 to 84.8 per cent [1] of normal in 1927 and from 79.6 to 85.3 per cent [2] in 1929, while the ranges for over-time men in the respective years were from 117.2 to 122.7 per cent [3] and from 113.7 to 122.8 per cent.[4] Here then is a situation where despite differences in business conditions as between the years, as well as differences in both the number of men and of firms, there is a marked similarity in the relation of short time and of over time to normal time in periods of seasonal activity.

Finally, how do actual and normal time compare as between firms? In the first place it may be noted that the men in each of the three groups (under-normal, normal and over-normal time) are distributed quite widely in both years. Normal time men are most widely distributed, being found in from 80 to 93 per cent of the firms. Short-time men come next in from 70 to 74 per cent of the firms, and the

[1] Excepting screw machine operating.
[2] Excepting boring mill operating.
[3] Excepting planer operating.
[4] Excepting turret lathe operating.

greatest concentration occurs with the over-time workers who are in from 49 to 57 per cent of the firms.

In considering how average actual time for firms compares with their normal time, the former will be expressed as a percentage of the latter. It then appears that actual time varies between firms from 71.4 to 124.2 per cent of normal in 1927 and from 66.8 to 133.8 per cent in 1929. This maximum range of 52.8 and of 67.0 per cent in the respective years is considerably reduced when, in each year, about one-tenth of the firms at each extreme are excluded. With these exclusions, which account for only about 6 per cent of the men each year, the actual time runs from about 90 to 110 per cent of normal, or a range of about 10 per cent either side of normal. For the largest firms, or those reporting 70 men, or more, the range is between 100.0 and 110.2 per cent, except in one instance where actual time is 95.8 per cent of normal.

Again the relation of actual to normal time is different on a yearly than on a weekly basis. Between the ten firms reporting in 1925 the actual time for full-year men averaged from 87.1 to 109.1 per cent, and from 89.3 to 110.7 per cent for the twelve firms reporting in 1926. This maximum range of about 10 per cent either side of normal approximates the range for about four-fifths of the firms on a weekly basis. However, there are only two firms in 1925 and two in 1926 where actual time averaged more than normal. Except for these firms average actual time varied on a yearly basis within a range of about 10 or 12 per cent below normal.

The foregoing analysis suggests the following conclusions. In the aggregate actual and normal time were fairly close in the two periods of seasonal activity despite differences in the business conditions of the two years. However, the similarity was greater for the combined than for some of the individual occupations. But this similarity does not warrant the inference that most of the men actually worked the normal time of their firms. Slightly over one-fourth of the men in each period worked less than their normal time, and on the basis of yearly data between 71 and 77 per cent averaged less than normal, with only 9 per cent averaging their normal time. Perhaps the most striking feature of the analysis is that in both 1927 and 1929 the degree of short time and of over time, in terms of hours, is about the same. Short-time men averaged about 16 or 17 per cent below their normal time while over-time men averaged between 18 and 20 per cent above their normal time. As between firms there is considerable difference in the degree to which the average actual time corresponds with normal time. Actual time for most of the firms on a weekly basis varied within a range of about 10 per cent either side of normal, and within a range of about 10 or 12 per cent below normal on a yearly basis.

THE NATURE AND USE OF THE HARMONIC MEAN

By Wirth F. Ferger, *University of North Carolina*

It appears from an examination of the treatment of the harmonic mean (the reciprocal of the arithmetic mean of the reciprocals of the items being averaged)[1] in a number of the popular textbooks on statistical methods, that there is a good deal of doubt and misapprehension in the minds of even our experts as to its true nature and usefulness. The current confusion was vividly brought home to the writer a few years ago the first time he tried to explain its use to a class of college juniors. Having been taught that the harmonic mean should be employed in averaging time rates, he used the example of the average rate at which three men load dirt into a wagon, one loading two, another three, and another four wagons per hour. Seeking to show that the arithmetic mean of three loads per hour was incorrect, he found, in front of the class, that it was perfectly correct—if it be agreed that the men all work the same length of time.

Several texts consulted at that time failed to elucidate the problem; some have no mention of the harmonic mean, while others merely give its definition with no consideration of its nature or use. Some texts give illustrations which are valid, but incomplete for a full understanding of the problem; a few give misleading and even impossible illustrations. Space limitations prevent detailed criticism: suffice it to say that all but four[2] of the 32 texts so far consulted leave much to be desired in adequacy, clarity or accuracy, in their treatment of the harmonic mean.

In presenting to a class the nature and usefulness of the harmonic mean, the writer has found the following illustration his favorite:

Let us consider three automobiles, A, B, and C.

Method I
- A travels at the rate of 10 miles per hour.
- B travels at the rate of 20 miles per hour.
- C travels at the rate of 30 miles per hour.

What is the average rate of speed for these cars? The arithmetic mean is 20 m.p.h., while the harmonic mean is 16.4 m.p.h. Which is

[1] The formula is $H = \dfrac{1}{\dfrac{\frac{1}{x_1}+\frac{1}{x_2}+\frac{1}{x_3}+\ldots+\frac{1}{x_n}}{N}} = \dfrac{N}{\Sigma^1_x}$, where $x_1, x_2 \ldots x_n$ represent the N values taken by the variable.

[2] Robert Wilber Burgess, *Introduction to the Mathematics of Statistics;* Truman L. Kelley, *Statistical Method;* C. W. Odell, *Educational Statistics;* Harold O. Rugg, *Statistical Methods Applied to Education.*

correct? The problem is indeterminate until it be agreed whether the cars shall be equally weighted in the sense of (*T*) all cars travelling the same length of *time*, or (*D*) all cars travelling the same *distance*. To put the matter differently, are the cars taxicabs *operating continuously*, say eight hours a day (*T*); or are the cars private vehicles carrying a group of people to a point, say 30 miles away, *each car making one trip?* The correct average will differ according to the condition agreed upon. Why?

How do we usually interpret the concept "average speed"? We mean that speed at which all three cars would travel if they maintained equal speeds and traversed the same total distance in the same total time. In case *T*, the total distance per day is $80+160+240=480$ miles; the total time is 24 hours, so the average speed is 20 miles per hour. In case *D* the total distance is 90 miles, the total time $3+1\frac{1}{2}+1=5\frac{1}{2}$ hours, so the average speed is 16.4 miles per hour. Then with speeds stated as they are in method I above,

Method I
- Case *T* requires the use of the arithmetic mean.
- Case *D* requires the use of the harmonic mean.

But the speeds of the cars could just as logically be stated as follows:

Method II
- *A* travels at the rate of 6 minutes to the mile.
- *B* travels at the rate of 3 minutes to the mile.
- *C* travels at the rate of 2 minutes to the mile.

Now the arithmetic mean is 11/3 minutes to the mile (or 16.4 miles per hour), while the harmonic mean is 3 minutes to the mile (or 20 miles per hour). Taking the same cases *T* and *D* above, with speeds stated as in method II,

Method II
- Case *T* requires the use of the harmonic mean.
- Case *D* requires the use of the arithmetic mean.

It is evident, then, that the blanket statement, "the harmonic average must be used in the averaging of time rates" is false. It must be used in *certain* cases of averaging ratios (not only time rates) where certain conditions are agreed upon. It differs from the arithmetic mean in giving more weight to the smaller items being averaged. (The reciprocal of a large number is small, and the reciprocal of a small number is large, relatively.) This is evidently appropriate in case I *D*, where the slow car (*A*) exercises more influence on the total time, and thus on the average speed. It is likewise appropriate in case II *T*, where the fast car (*C*) exercises so much more influence on the total distance travelled.

To summarize the rule, the principal use of the harmonic mean is in certain cases of averaging rates. Rates, being ratios, may always

be stated in two forms, keeping one or the other of the factors constant —in the above illustration, (T) time, or (D) distance. The conditions of the problem for which an average is sought will determine which of the factors *should* be kept constant (whether the cars shall all travel equal distances or equal times). If it is desired to keep constant that factor which is constant in the rates as stated, then the arithmetic mean should be used: if, on the contrary, the recorded rates make variable the factor desired to be constant, then the harmonic mean is the correct average to be employed.

A few further illustrations will show that this problem is frequently encountered, and should be thoroughly understood by all statisticians and students in research. This is being written on the day following the Indianapolis Speedway races. What was the average speed of all cars finishing the 500-mile race? Clearly the correct average (if the speed of each car is stated in miles per hour) is the harmonic mean. On the other hand, the average time of several runners in the 100-yard race would be the arithmetic mean (since the speed is stated in seconds per 100 yards). If a time-and-motion study expert records the time taken by different workers to perform a given operation, what is the average time of all workers? Clearly the harmonic mean, if all the workers put in the same number of hours per day. If data of ship speeds be given, as is commonly done, in the form of so many days per turn-around (round trip), the average speed of several ships would obviously be the harmonic mean, since the ships operate continuously. Suppose we record the number of arithmetic problems correctly completed by different pupils in a five-minute test: what is the average rate of speed at which they work? If the pupils be thought of as all working the same length of time, then the arithmetic mean is correct: but if the average rate at which they all prepare the same assignment of home-work be sought, then only the harmonic mean is accurate. Burgess [1] differs with Kelley [2] as to which of these interpretations gives the more meaningful answer.

A still more harassing situation is met in the computation of index numbers of prices. Prices are, of course, ratios, and may be stated either as so much per unit, or so many units to the dollar. Clearly the arithmetic mean of prices in one form is equivalent to the harmonic mean of the same data stated in the other form. (The reason for this is evident when it is noted that the prices stated in one form are merely the reciprocals of the same prices stated in the other form.) But, given prices stated in the customary manner of so many dollars

[1] Robert Wilber Burgess, *Introduction to the Mathematics of Statistics*, p. 95.
[2] Truman L. Kelley, *Statistical Method*, p. 64.

per unit, which is the correct average? What would we be assuming if we used the harmonic mean? We would be assuming that, with the prices of given commodities changing, people spend the same amount of money, getting more or fewer units for their money. The use of the arithmetic mean assumes that people, during rising prices, buy the same *quantities* of goods, paying more for them. Which is the case? The answer is not clear. For a measure of prices over a long period (as, for instance, to show the trends of prices since 1875) it would seem that the latter would more nearly fit the facts. As the prices of all or most commodities change (a change in the price level, or the purchasing power of money), there is a tendency for wages and salaries also to change in the same direction—the price of labor tends to follow the course of other prices—so that people's purchasing power *tends* to remain constant. There are time lags and "economic friction" involved here, but the usual assumption that the quantity of goods remains constant is probably nearer the truth than the opposite assumption. In this case the problem is not in aggravated form, however, because changing weights can be approximately determined and used (as in the "Ideal" index formula).

But for most practical purposes in current month-to-month indexes, constant weights must be employed. Now the problem is insistent: should the weight of a commodity be kept constant from month to month in the sense of equal *quantities* being bought, or in the sense of the *expenditure* remaining the same? The latter would seem to command serious consideration in view of the elasticity of the demand for many, if not most, commodities, and since the incomes of most people do not fluctuate closely or immediately with the cost of living. This latter assumption would obviously require the use of the harmonic mean of relatives of prices stated in the usual form of so much per unit. It matters not whether the elasticity of demand is due to the commodity being a luxury, or to the availability of a satisfactory substitute. Even "necessities" may conform to this tendency: consider the weight which should be given, from month to month, to "eggs, strictly fresh," or potatoes, or oranges, or cabbage. Even necessities such as shoes and clothes may have elastic demands, especially when quality, looks and style are considered.

It should be noted that the problem is not a decision between unweighted and weighted index numbers, but between the senses in which given weights are to be held constant between the base period and the given period. A weighted harmonic mean $\left(H = \frac{\Sigma w}{\sum \frac{w}{x}}\right)$ of rela-

tives is implied as against a weighted arithmetic mean. The formula, using the common notations of zero subscripts to denote base year, and 1 subscripts to denote given year prices, quantities, and values, follows:

Harmonic Average-of-Relatives Price Index

$$= \frac{\Sigma v_0}{\sum \frac{v_0}{p_1/p_0}} = \frac{\Sigma v_0}{\sum \frac{v_0 p_0}{p_1}} = \frac{\Sigma p_0 q_0}{\sum \frac{p_0^2 q_0}{p_1}}.$$

The question may be put in another form: does not the "downward bias" of the harmonic type of formula really represent a closer approach to actuality in measuring prices (with fixed weights) than the formulas in common use—the aggregative and arithmetic or geometric average-of-relatives? Our economic theory explains the ordering of our economic life through the price system—the function of prices is to stimulate or discourage consumption as well as production, on the basis of the elasticity of demand. Should we not recognize in our index numbers that people do *not* buy equal *quantities* of goods as prices vary, but change their purchasing habits with shifting prices. Does not the "downward bias" represent actual economies of the housewife in exercising common sense in the selection of commodities, and so more nearly approximate actual weights?

Two peculiarities of the harmonic mean should be mentioned. Several writers have pointed out the fact that the harmonic mean of a given distribution is always smaller than both the arithmetic and geometric means. In this connection it would be well to correct an error which (doubtless through an oversight) crept into Žižek's study [1] and which has been propagated in at least two subsequent texts. The more exact relationship, that "of the three means of the same set of values the geometric is the geometric mean of the other two" is true only in the special case of averaging just two items.

The second peculiarity is that the harmonic mean cannot be employed for the average of a distribution where the variable even once takes the value zero. Reflection will show the reason: the taking of reciprocals in this case would involve division by zero, an operation excluded from arithmetic and algebra because meaningless. This mathematical limitation exposes a logical inconsistency in our problem: we should not seek the average speed at which several autos travel (all to travel equal distances) when one is standing still!

[1] Franz Žižek, *Statistical Averages, A Methodological Study*, p. 132.

ORGANIZATION OF STATISTICS IN POLAND

By Ludwik Landau

In Poland, as in other countries, statistical investigations are conducted by the Government, by local authorities and by private institutions. In so far as Poland is concerned, a characteristic feature is to be found in the dominating position of State statistics and in particular of the central authority conducting statistical investigations, *viz.*, the Central Statistical Bureau.

The Central Statistical Bureau (Glowny Urzad Statystyczny) was created in the very first moments of the restoration of the independent Polish Republic. The Act of 1919, while making the Bureau the chief authority as far as governmental administrative statistics are concerned, placed it directly under the Council of Ministers. Since 1923, however, the Director of the Bureau has been subordinate to the Minister of the Interior. The aim of the Central Statistical Bureau is to concentrate all governmental activities in the field of statistics. Most investigations are conducted directly by the Bureau; if, on the other hand, other authorities are in charge of the investigations, the Bureau's rôle is to publish the results or summaries thereof and to give uniform direction. To enable the Bureau to perform this task it is empowered by the Act to examine every projected statistical investigation. In case of disagreement between the Bureau and the Ministry in question, ultimate decision rests with the Council of Ministers.

Besides the Director's office the Central Statistical Bureau is composed of nine Divisions—of the Census, of Vital Statistics, Criminal Statistics, Education, Agriculture, Industry, Foreign Commerce and Transportation, Finance and Local Government, and Social Statistics.

Before characterizing the activity of the Bureau according to its structure, let us consider a problem of more general nature, that of the 1921 Census. According to the present status the census work is not concentrated in any one division; population and occupation censuses are executed by the Census section proper, the agricultural census by the Agriculture section, and the census of manufacture by the Industry section. The 1921 Census, nevertheless, covered jointly the following sub-censuses: of population, of occupations, of buildings and dwellings, of orphans (because of the post-war conditions), of farms, of jointly-owned lands and of livestock.

The Census was taken as of September 30, 1921, no more than one year after the cessation of war activities on the Republic's territory.

At this time general conditions were still far from being normal, especially with regard to population and economic conditions. Therefore the 1921 census data must be regarded today as largely obsolete, nevertheless they are to be considered as basic for a study of the population and occupational structure of Poland, as well as of agricultural conditions. It should be noted that this Census did not cover those portions of the Republic which were incorporated later—Upper Silesia and the Wilno district.

The compilation of the census data took several years because of the wide scope of the investigation and of the comparatively small number of employees, due to budgetary difficulties. Most data have been compiled on Powers' tabulating machines. The results are published in 23 volumes. One volume is devoted to each of the following subjects: farms, jointly-owned lands, buildings, households, and places of birth. The remaining 18 volumes cover the housing, population and occupation statistics, one volume for each territorial district, besides a general volume. The statistics of buildings and dwellings in Poland, as contrasted with most other countries, cover not only cities but rural districts as well, giving thus a many-sided picture of the prevailing conditions. Special attention was given to occupational statistics. The classification was done on a threefold basis: (1) from the objective point of view, according to the business enterprise or institution by which the given person was employed; (2) from the subjective point of view, according to the kind of work done; (3) according to the social and occupational position held. All those criteria are combined in the final compilation. The census of farms gives a classification according to the size of farms and the apportionment of land to the several uses.

A directory of localities was also published as a supplement to the publication of the census data. This was especially important for that part of the Republic which belonged formerly to Russia, where the last census had been taken in 1897. This Directory gives, moreover, for each locality the division of its population according to religion and nationality (race), giving thus a thorough insight into the racial structure of Poland.

It had been planned to take the next census on December 31, 1930, and subsequent censuses every ten years thereafter, but the date has been shifted to 1931 and October has been selected as a more advisable time.

The collection of vital statistics was organized in 1920 in the part formerly under Prussian government, while in the Southern districts (formerly Austrian) it was established in 1926, and in the former

Russian territory in 1927. In the last named part of Poland vital statistics, properly so called, never existed, as the pre-war Russian government gathered only summary data through local authorities. Now vital statistics are thoroughly standardized over the whole territory of the Republic and detailed investigations concerning births, deaths and marriages are possible.

Criminal statistics are conceived as statistics of persons finally convicted by courts for crimes and misdemeanors (with the exclusion of minor offenses). Those statistics were originally collected by the Ministry of Justice; now they are gathered by the Central Statistical Office. In conjunction with this, statistics of protested bills are compiled. Statistics of real estate transfers and mortgages are also in preparation.

The Division of Educational Statistics in collaboration with the Ministry of Public Education (which makes, however, some statistical investigations independently) gathers data concerning the number of schools, students, teachers, their qualifications, etc., as well as data concerning evening schools, extension courses, libraries, periodicals, etc.

All inquiries concerning agriculture, whether periodical or occasional, are conducted by the Division of Agricultural Statistics. The 1921 Agricultural Census, as noted above, covered a census of farms, of livestock and of jointly-owned lands. Moreover, detailed investigations were conducted concerning great holdings. A special census made in 1921–1923 covered all holdings above 50 hectares (about 100 acres). Attempt was made to get data concerning not only the number of holdings of farms, the area and its division among the several uses, but also the methods of farming. A second census of livestock was made on November 30, 1927, and on June 30, 1929, a registration of livestock through the local authorities was made effective. The next Agricultural Census is projected for 1931.

As far as periodical investigations in agriculture are concerned, the most important are statistics of agricultural production, i.e. of sowings and crops. These have been collected by the Central Statistical Bureau from the very beginning of its existence, The data were originally gathered through agricultural correspondents, throughout the country. Being farmers, rural teachers, etc., they fulfilled their duties without consideration. They sent data concerning those farms of which they had personal knowledge, giving information on the areas devoted to the several crops. The Bureau computed the ratios of the areas of those crops to the total area of arable land in the given farms and then applied those ratios to the total area of arable land in a given territory, estimating thus the absolute size of crop areas. Similarly data on

yield per unit of area were given by the correspondents and served as a basis for estimating total crops. The number of correspondents has been constantly increasing; it totaled 2,600 in 1922, and 6,600 in 1929. Nevertheless, data on sowings and crops, estimated in the way outlined above, were of somewhat doubtful accuracy. Since 1927–1928 the method was essentially changed. The area of sowings is now determined on the basis of a registration made by local authorities in July of each year. Thus the Central Statistical Bureau receives data on the area of every crop computed for all farming enterprises. After the harvest is made the local authorities furnish again data on average yield, and total crops are estimated on the basis thereof. The correspondents also furnish information on weather conditions, on the state of sowings (in degrees from one to five) and on the course of the harvest, thus enabling the Bureau to make forecasts on the volume of crops.

As far as livestock breeding is concerned, aside from livestock censuses, statistics of slaughtering are compiled and published every quarter.

Among other investigations in the field of agricultural statistics the following should be mentioned: statistics of prices of farm products (grain, livestock, dairy products, etc.) paid locally to producers, and statistics of prices of land. Both are based on the correspondents' reports.

The task of the Industrial Statistics Division is to conduct any investigation concerning manufacture. Poland still lacks a general census of manufacture; the first will be, probably, combined with the population Census of 1931. For some time, however, statistics of manufacture have been collected yearly concerning the volume of production, the amount of raw materials used, stocks of products and raw materials, productive capacity, motors and machines, fuel and lubricants used, number of clerical employees and laborers. Those investigations cover, in principle, all manufacturing enterprises employing five or more workers. The low level of education of the small business men is a source of serious trouble in collecting data, which is being increased in scope little by little. Partially, however, lack of appropriations prevents the Bureau from tabulating all the material available. At any rate for most branches of manufacture (mining and foundries, *cf. infra*) the data on number of employees and laborers, on motors and their aggregate power, and on the volume of production are already published. Statistics of value of production are just being introduced.

Some aspects of the situation in manufacture are the subject of investigations conducted at more frequent intervals, *viz.*, the employ-

ment data in manufacturing industry (mines and foundries excluded) in establishments employing twenty or more workers each. Thus all the great and medium-size establishments are covered, and to some extent even the small ones. Data are collected monthly taking account of the following items: number of laborers employed with special reference to those employed directly in production processes, number of days and hours worked, unfilled orders. Of these most attention is given to the number of worker-hours in every branch, which can be regarded as a substitute for non-existing monthly statistics of production. These statistics were started by 1920, but were not organized along uniform lines until 1925.

It should be noted that no investigations of the Central Statistical Bureau cover the field of mining and foundries, such investigations being conducted by the Ministry of Industry and Commerce.

Statistics of building activity are still in the stage of organization. Up to the present time only data pertaining to buildings erected by private persons and city governments in cities of over 25,000 inhabitants are gathered through the intermediary of the city governments. The scope of these data extends to the number of new constructions and alterations begun and finished. It is proposed to cover in the near future all incorporated cities, and to collect detailed data as to the size of the buildings, the materials used in construction, etc.

The Division of Foreign Trade and Transportation Statistics collects data mainly on imports and exports. Of the statistics of transportation by far the most important branch, railway statistics, is compiled directly by the Ministry of Transportation (practically all railroads in Poland are publicly owned and operated). Similarly, the Ministry of Post and Telegraphs collects data in the field of its activity.

Statistics of foreign trade were collected from the very beginnings of the independent Republic. They cover the territory of the Polish Customs Union, i.e. of Poland proper together with the Free City of Danzig. Up to 1923 only quantity data were collected because of the wide fluctuations of prices caused by monetary inflation. Since 1924, on the other hand, both quantities and values have been taken into account. Both are determined on the basis of returns filed by the importers and exporters themselves; the values, however, are checked by reference to available price-lists. Since 1924 tabulating machines have been used, permitting comparatively early publication of results. First, provisional data for the most important commodities without regional allotment are published on the twentieth day of the month. Ten days later more detailed data are published with almost 1,300 separate headings, each of which is discussed with regard to the most

important countries of import and export. Definitive data are published yearly in yearbooks, where all the details are considered. Since 1929 in accordance with the resolutions of the International Statistical Conference in Geneva with regard to business statistics of 1928, conditional turnover was treated together with statistics of special trade. Statistics of through traffic of foreign goods (transitory trade) are being collected in yearly compilations.

In the field of transportation and communication the Central Statistical Bureau's activity is restricted mainly to publication of data collected by various institutions and agencies: railroad and postal statistics being collected by the respective Ministries, marine statistics in the port of Gdynia by the Naval Bureau, those on air transport by the various air transportation companies. The Bureau also publishes automobile statistics of registered motors and of interurban autobus traffic as well as of the inland water transportation facilities.

The Division of Financial, Municipal and Communal Statistics collects data pertaining to public finance, the credit situation and business enterprises. As to government finance the Bureau does not collect data independently, but uses data released by the Ministry of Finance. However, the arrangement of data pertaining to municipal finance calls for special research work; thus, in order to obtain data on the financial activities of the different municipal enterprises as well as on the various cities and towns, the Bureau has to look into the various balances with regard to larger cities, and is obliged to use the questionnaire method in so far as towns and villages are concerned. Municipal credit, loans and debts, their size, sources, and conditions upon which loans are being contracted, as well as the purpose of the loans, form a special part of the Bureau's statistical research.

With regard to the credit situation the Bureau collects balances and data in connection with the activities of the great majority of credit institutions. Furthermore, the Bureau collects data on interest rates, on loans and deposits, bond and stock prices, and prepares an index of 45 stocks. Since 1923 the Bureau has compiled yearly Poland's international balance of payments; in connection with this work, problems closely related to Poland's activity on international money, credit and commodity markets have been dealt with.

With regard to trade, commerce and industry, the Bureau's work is based upon data derived from the compulsory registration of joint stock companies, corporations and partnerships; the questionnaire method is used with regard to limited liability companies and coöperative societies in order to obtain detailed information; statistics of bankruptcies are supplied by court proceedings.

The calculation of national wealth and national income is now being taken up by the Bureau. Up to now such calculation was handicapped by lack of data concerning the value of production.

The Division of Social Statistics carries on investigations concerning conditions of work, standards of living of the working population, and the price movements. In connection with this activity problems of unemployment and migration are being studied by the Ministry of Labor and Social Welfare and also by the Emigration Bureau.

As to conditions of work the most important problem is the statistics of wages. These statistics have been carried on steadily, at first with regard to certain branches of industry only, then, since 1924, with regard to all the important industries, on the basis of standard wages. Such statistics indicate fluctuations in wage rates, but do not show the magnitude of actual earnings, the fluctuations of which disagree very often with those of standard wages. Collection of statistics of earnings in the coal industry, together with production, is conducted by the Ministry of Industry and Commerce. In other branches investigations on a larger scale were begun as late as 1928; these investigations relate primarily to ore mining and foundries, though occasionally wages in the textile, metal and building industries are published. Also data as to strikes and lockouts, size of strikes (number of strikes and labor days lost) and the cause and results of these disputes are computed. Standard of living of wage earners is studied on the basis of family budgets; these studies, pertaining to workers' families in the industrial districts of Warsaw and Lodz and the mining districts of Dombrova and Silesia, were initiated in 1926. Data for 202 workers' families were collected and published for the year 1927.

The Central Statistical Bureau collects data relating to prices, retail and wholesale. A special type of prices, namely prices of agricultural products paid to producers, is being investigated in connection with agricultural statistics. Price indexes first were calculated on the base 1914 = 100; later the first six months of 1925 were taken as a base, i.e. the period before the depreciation of the zloty, which became stabilized at the end of 1926; at present all price indexes are based on 1927 = 100. The wholesale price index, constructed in 1921, included at the beginning prices of 57 commodities and was calculated as an unweighted geometric mean of the several price relatives; since 1927 the basis for the index has been widened, and 73 commodities are now taken, and the index is calculated as a geometric mean. Besides the general index, separate indexes for agricultural and industrial commodities as well as eight subgroups of commodities are computed. With regard to retail prices an index of such prices in Warsaw is computed;

this index includes 52 commodities divided into 18 groups. The group indexes are calculated as unweighted geometric means, while the general index is a weighted mean of the groups.

An index of cost of living in Warsaw is also computed. This index includes costs of food, clothing, heating, rent, amusement, education, etc., and is calculated as a weighted arithmetic mean based upon a theoretical family budget; for 175 other cities and towns the cost of foodstuffs only is calculated.

Among sporadic investigations carried out by the Bureau is the census of government officials taken in 1923, and statistics of parliamentary elections.

It follows that the activities of the Central Statistical Bureau include almost every field of economic life, except for the few problems which are cared for by other government offices. Such varied activity is expressed by numerous publications of the Bureau. Since 1920 the Statistical Yearbook of the Republic of Poland (*Rocznik Statystyki Rzeczypospolitej Polskiej*) has been published, which contains data supplied by the Bureau and other governmental agencies. A statistical atlas was published by the Bureau in 1929 with a view to popularizing the science and use of statistics. From 1920 to 1923 the Statistical Monthly (*Miesiecznik Statystyczny*) was issued; in this monthly statistical material, results of investigation and current data were discussed. Since 1923 two publications have replaced the monthly. Current statistical data and short summaries of more extensive investigations are published in The Statistical News (*Wiadomosci Statystyczne*), a bi-weekly, while the results of statistical research of practical as well as of theoretical nature are discussed in The Statistical Quarterly (*Kwartalnik Statystyczny*). This publication does not contain problems of social and labor statistics, which are collected in a special publication under the name Labor Statistics (*Statystyka Pracy*) (at the beginning a monthly and since 1927 a quarterly). Data concerning international trade, in so far as monthly figures are concerned, were published irregularly till 1923, partly in special publications, partly in the Statistical Monthly; since 1924 all questions relating to international trade are discussed in a periodical International Trade (*Handel Zagraniczny*), originally a quarterly and since 1927 a monthly publication. Complete and verified data relating to international trade are found in a yearly publication Yearbook of International Trade (*Rocznik Handlu Zagranicznego*). Other periodicals are Statistics of Slaughtering (*Statystyka Uboju Bydla*), a quarterly, and Statistics of Prices (*Statystyka Cen*), a monthly in 1929, a quarterly since 1930.

Among irregular publications the most important is The Statistics of Poland (*Statystyka Polski*); this publication contains primarily the results of all the major statistical investigations. Being issued serially it contains the results of various censuses which have been taken by different government agencies; thus 26 volumes are given over to the results of the general census taken in 1921. On the basis of this census a directory of cities and towns and villages was published in 15 volumes.

The activity of the Central Statistical Bureau is not restricted to collection, tabulation and publication; analytical and scientific research forms a considerable part of the Bureau's daily work. The results are published in The Statistical Quarterly and Labor Statistics. Thus, for instance, the first number of the 1930 volume of The Statistical Quarterly contains the following material: "Measure of Growth of Population"—an article dealing with methods in vital statistics, "The Second General Census"—an article discussing methods to be used in the next census on the basis of experience gained during 1921 and in foreign countries (in this article 21 different census blanks are compared), "Marriages, Births and Deaths in Southern Districts in 1926," "University Libraries," "Sowing and Crops in 1928–1929," "Municipal Banks in Poland during 1926–1928," "Live Stock in Poland," "Current Publications—Notes and Reviews," "Statutes and Ordinances."

It has been mentioned that statistical investigations are being carried on not only by the Central Statistical Bureau, but also by other governmental agencies. The Ministry of Industry and Commerce collects data on mining and foundries. These data concerning volume of production, employment (and in the coal industry earnings also) are published monthly.

The Ministry of Transportation publishes general data concerning freight and passenger traffic. Besides these figures very detailed tables are published concerning transportation of 137 different groups of products from station to station; less detailed data are published in quarterly intervals.

The Ministry of Post and Telegraphs collects data with reference to post, telegraph and telephones. These data are published yearly, and monthly with regard to 14 largest cities.

The Ministry of Finance publishes statistics on assessed and collected taxes, especially direct taxes.

The Ministry of Labor and Social Welfare collects data on unemployment. These data are based on registration of persons seeking jobs in the government employment exchanges. The data thus collected give a true picture of the unemployment situation, because

unemployment benefits are made contingent upon such a registration of the unemployed. This leads to collection of data relating to the number of persons receiving unemployment relief. The Ministry also collects statistics on unemployment or social insurance, and the Emigration Bureau on emigration and immigration.

The Ministry of the Interior collects data concerning health of the population and sanitary conditions; and the Ministry of Justice compiles court and prison statistics.

To institutions which to a lesser degree carry on statistical investigations, but which synthesize data already on hand, belongs the Institute for Economic Research (Instytut Badania Konjunktur Gospodarczych i Cen). Among the current work the most important is the preparation of indexes as follows: general index of industrial production, indexes of prices of manufactured and semi-manufactured commodities, index of prices for building material, index of wages, index of unemployment (in percentages), index of commercial paper and acceptances, indexes of yield on government and municipal bonds. The Institute publishes a monthly, *Konjunktura Gospodarcza*, the English compendium of which bears the name *Polish Business Conditions*, and also a series of monographs on the business situation and methods of research.

Much statistical material has been collected and arranged by the Enquette Commission of 1927–1928, partly systematizing already available data, partly carrying on its own investigations. The results are presented in 15 volumes discussing different industries.

Communal and municipal statistics constitute a much smaller field of action. They are largely conducted by city governments, because other local authorities do not compile statistical data. (The Central Statistical Bureau has prepared a project of statistical investigations to be carried out by the counties, but so far the project is only beginning to be realized.) In so far as cities are concerned, statistical data are being constantly compiled and arranged. The large cities have their own statistical bureaus, other cities have commissioners of statistics or transfer the statistical work to permanently established bureaus. A comparatively small number of cities do not collect statistical data regularly. Almost all of the cities which have established statistical bureaus publish monthlies containing currently collected data, and most of the cities publish yearbooks often containing interesting statistical material.

Coördination of methods employed in urban statistics is achieved through conventions of statisticians. The first convention was organized by the Central Statistical Bureau in 1921, with the purpose of

standardizing and systematizing the material. The Bureau also initiated the publication of the Yearbook of Urban Statistics. The last convention took place in 1930.

The most important fields of urban statistics are: vital statistics, migration, sanitary conditions, social welfare, building, prices, municipal finance, consumption. Statistics of population take into consideration some characteristics of marriages, births and deaths, which the state statistics do not take notice of. Thus, for instance, in some cities a division of marriages according to profession of bridegrooms is introduced. Statistics of migration are based upon police registration of the inhabitants of the city. Sanitary statistics concern themselves with epidemics, hospitals, the activity of medical emergency aid, health insurance, etc. As to social welfare, statistical inquiry is confined to the numbers receiving benefits or who otherwise become a charge to the community. Building statistics are not wider in scope than state statistics. Statistics of consumption consider primarily the turnover of livestock in the markets, consumption of water, electricity and gas.

Besides, the urban statistical bureaus coöperate with state authorities whenever state-wide censuses are taken. Sometimes the cities take their own censuses. The very well organized census of real estate and apartments in 1919 in the city of Warsaw ought to be mentioned here.

Private statistical investigations, especially with regard to business situations and conditions, despite their importance, are as yet undeveloped. However, many industrial associations are conducting statistical investigations, publishing the results in yearly reports. Thus, for example, the Association of Polish Iron and Steel Founders, a nation-wide organization, the Association of Textile Industry, covering the largest enterprises, and finally the Export Associations of the Metal, Textile and other Industries, have statistical departments.

Among other institutions the Institute of Social Economics conducts various investigations pertaining to social problems, like living conditions of wage earners, working time in different industries, etc. Statistics of labor unions—the materials on which in many countries unemployment statistics are based—are in the initial stage of development in Poland.

Scientific societies of an exclusive statistical character do not exist. However, The Society of Polish Economists and Statisticians in Warsaw gives much time to statistical problems. The Society publishes a quarterly, The Economist (*Ekonomista*). Knowledge of statistics is spreading steadily together with progress in administrative statistics.

NOTES

A DISTORTION IN THE COST OF LIVING INDEX

By Margaret H. Hogg, *Russell Sage Foundation*

The cost of living index of the United States Bureau of Labor Statistics is in constant use to indicate changes in purchasing power of money, and hence in real wages and real earnings; it has therefore a function of considerable importance. The index is often said to be not so representative as is desirable because of the limited data, both on consumption and on prices, with which the Bureau is provided, and a plea is made for further data. The purpose of this note is to show an evident distortion present in the index, preëminently for the period 1916 to 1921, and to indicate an improvement which can be made *now*.

The Bureau constructs its index on the usual hypothesis that the relative *consumption* of different commodities remains unaltered month by month and year by year, although changes in price may cause relative *expenditures* on different commodities to change. That is, the index adopted is a series which compares, at successive dates, the cost of a standard budget of constant commodities and quantities. The construction procedure is to combine commodity price indices based on 1913 by weights taken to represent proportional expenditure on the respective commodities in 1913, and as the only considerable body of expenditure data obtained for any time since 1901 is that of the Bureau's cost of living investigation of 1917–1919, it is natural to use these data to provide expenditure weights for the series. This the Bureau did, but unfortunately in such a way as to cause considerable distortion. To proceed consistently with its own investigation results, the Bureau should have used expenditure weights which assumed as constant, over the time covered by the index series, the consumption habits found by investigation in 1917–1919. Instead, it assumed as constant over the period consumption habits which differ markedly from those found in 1917–1919 and for which there is no evidence at any date. This assumption, apparently generally unnoticed, is implicit in the adoption, unadjusted, of the 1917–1919 expenditure distribution to represent expenditure distribution in 1913.

Table I shows what considerable contrast exists, especially for rent, between the expenditure distribution actually found and that imputed by the Bureau's index. This table represents also the contrast between

TABLE I

EXPENDITURE DISTRIBUTION IN 1917–1919, AS INVESTIGATED AND AS IMPUTED

	From 1917–1919 investigation	As imputed by B. L. S. index *
Food	38.2	41.5
Clothing	16.6	18.6
Rent	13.4	8.8
Fuel and light	5.4	4.6
Furniture and furnishings	5.1	5.9
Miscellaneous	21.3	20.6
	100.0	100.0

* Assuming a simple average of prices in December, 1917, and December, 1918, to represent the average prices for the investigation period.

the investigated and imputed consumption habits, since prices are the same for both distributions. The table is constructed as follows. If E was the total expenditure on a standard budget in 1913, the Bureau assumes that .382 E was then spent on food, .166 E on clothing, .134 E on rent, .054 E on fuel and light, .051 E on furniture and furnishings, and .213 E on miscellaneous items. To discover what assumption this entails as to expenditure distribution at the time of the investigation, price indices have to be adopted for the investigation period, and the averages of price indices for December, 1917, and December, 1918, have been here used, since the investigation extended from the latter part of 1917 to the early part of 1919. Proceeding, we find that for the investigation period the Bureau assumes that, for

Food, the index being	172.0	the expenditure was 1.72	$\times .382E = .6570E$
Clothing, the index being	177.2	the expenditure was 1.772	$\times .166E = .2942E$
Rent, the index being	104.65	the expenditure was 1.0465	$\times .134E = .1402E$
Fuel and light, the index being	136.0	the expenditure was 1.36	$\times .054E = .0734E$
Furniture and furnishings, the index being	182.1	the expenditure was 1.821	$\times .051E = .0929E$
Miscellaneous, the index being	153.15	the expenditure was 1.5315	$\times .213E = .3262E$

This gives a total expenditure of $1.5839E$ which means that the expenditure weight imputed to food is $100 \times \frac{.6570E}{1.5839E}$ or 41.5, and similarly for other items.

Having seen the distortion by the Bureau of its own data for 1917–1919, we have next to consider what the procedure should logically be. As the index takes 1913 as its base period, 1917–1919 expenditure on each commodity should be adjusted for its price-change since 1913 to produce the probable expenditure in 1913, and the resulting percentages (of total probable 1913 expenditure) should be used as weights in constructing an index on a 1913 base. Adjustment takes place by procedure similar to that for Table I, except that the price indices

appear in denominators instead of in numerators. Calling the total expenditure from the 1917–1919 investigation E', then the expenditure in 1917–1919 was $.382\,E'$ on food, $.166\,E'$ on clothing, and so on. For food, the index for 1917–1919 being 172.0, the expenditure in 1913 should be $\frac{.382\,E'}{1.72} = .2221\,E'$. The other items are similarly dealt with, giving a total expenditure for 1913 of $.6507\,E'$, which means that the expenditure weight to be given to food is $\frac{100 \times .2221\,E'}{.6507\,E'} = 34.1$, and similarly for the other items. Table II, column (b), gives these adjusted weights, which should logically be used for an index on a 1913 base.

In the study of the National Industrial Conference Board,[1] adjustment of the Bureau's expenditure distribution back to 1913 was made by Margaret Stecker in an attempt to evaluate the factors contributing to the divergence between the official index and that of the Conference Board, but the argument was not developed and no one since appears to have followed it up. The Conference Board moreover has, like the Bureau, itself omitted to adjust its expenditure data for price changes between the period of investigation and 1913. It has rejected the data of the 1917–1919 study, and uses that of the federal cost of living investigation of 1901, with slight modification based on a number of small inquiries. As the dispersion of price indices for 1913 on the base 1901 is less than that of indices for 1918 based on 1913, the distortion arising from lack of adjustment is less in the Conference Board index than in the official one. No price index exists for miscellaneous items prior to 1913, hence adjustment of 1901 expenditure weights requires some assumption concerning a probable index. No table similar to Table I has been constructed, but Table II provides sufficient evidence of distortion in both indices.

Table II shows in columns (a) and (b) respectively the distribution of expenditure to be expected in 1913 if the distributions of the 1901 and 1917–1919 investigations are adjusted according to the available evidence concerning intervening price changes, that is, it shows the expenditure distributions for 1913 which would have occurred if consumption habits had been as in 1901 and as in 1917–1919 respectively. In columns (c) and (d) appear the expenditure distributions imputed to 1913 by the two published indices. Column (a) is based on an assumption that the average price change for miscellaneous items was the same as the average for the rest. This was probably not exactly the

[1] *Cost of Living in the United States*, National Industrial Conference Board, New York, 1925, p. 111. December, 1918, prices are there taken as representative for the 1917–1919 investigation. The lateness of that date exaggerates the adjustment.

TABLE II

EXPENDITURE DISTRIBUTION IN 1913, AS EXPECTED BY ADJUSTMENT AND AS IMPUTED BY INDICES

	Expected Distribution		Distribution Imputed	
	Adjusted from 1901 data (a)	Adjusted from 1917–19 data (b)	By B. L. S.* (c)	By N. I. C. B.† (d)
Food	41.3	34.1	38.2	43.1
Clothing	12.5	14.4	16.6	13.2
Rent	21.1	19.7	13.4	17.7
Fuel and light	4.6	6.1	5.4	5.6
Furniture and furnishings	3.1	4.3	5.1	3.0
Miscellaneous	17.4	21.4	21.3	17.4
	100.0	100.0	100.0	100.0

* Actually unadjusted distribution of 1917–1919.
† Actually unadjusted distribution of 1901, slightly modified by addition of some small later investigations.

case, but no modification would be likely to have such effect on the contrasts of percentages as to disturb the present argument.

It will be seen that half the percentages in each of columns (c) and (d) lie outside the range between those in (a) and (b). Most striking is the approximate agreement of the percentages for rent as adjusted from the two investigations, from which the percentage used in the official index falls short by one-third.[1] No alternative hypothesis for the price behavior of miscellaneous items could change column (a) sufficiently to upset the contrast regarding rents, nor could it resolve the general discord of (c) and (d) from (a) and (b) into harmony. It is not possible, whatever the price changes for miscellaneous items, that the presumption of either published index should agree with either adjustment of known expenditures to the year 1913 or with any compromise between the two; therefore modification seems desirable in both index-series.

The opinion is often expressed that the expenditure distribution of 1917–1919 suffered from an abnormality due to sharp change in expenditure habits, as well as from abnormality caused directly by the varied rapidity in rise of different prices. It is then argued that the supposed abnormality of consumption habits in 1917–1919 makes data from that period inapplicable, even by adjustment, to following and to preceding years. In considering this question of consumption, the price-change element needs to be eliminated, hence columns (a) and (b) in Table II provide the proper contrast. They show the expenditure distribution, with the same prices, which would arise from consumption

[1] For rents prior to 1913 the "Russell Sage Foundation Index" is used. This was published in *Business Cycles and Business Measurements*, by Carl Snyder, p. 291.

habits of 1901 and of 1917–1919 respectively. The change in habits which they suggest seems more reasonable than that which might be mistakenly inferred from comparison of the unadjusted expenditures. All significant changes are in the direction of social progress, the apparent retrogression with respect to house accommodation being corrected; therefore one may question to what extent the 1917–1919 consumption habits were a temporary aberration from a norm rather than one stage of a continuous adaptation to rising real wages.

A new cost of living inquiry is much needed, but until new budgetary data are available, the most desirable course appears to be to regard the 1917–1919 data as typical of 1918, and to assume as usual that expenditure changes in earlier and later years were due to changes of price, not of consumption habits. For the Conference Board index, such modification would have comparatively small effect; figures from July, 1916, to July, 1920, would be lower and figures from November, 1920, to March, 1928, would be raised, the greatest difference being 2.8 units in July, 1921.

TABLE III

ADJUSTMENT OF COST OF LIVING INDEX OF UNITED STATES BUREAU OF LABOR STATISTICS

	Official index	Adjusted index	Difference		Official index	Adjusted index	Difference
Dec. 1914	103.0	102.7	.3	Sept. 1923	172.1	172.4	−.3
Dec. 1915	105.1	104.8	.3	Dec. "	173.2	173.4	−.2
Dec. 1916	118.3	116.8	1.5	Mar. 1924	170.4	170.9	−.5
Dec. 1917	142.4	138.9	3.5	June "	169.1	169.9	−.8
Dec. 1918	174.4	168.5	5.9	Sept. "	170.6	171.2	−.6
June 1919	177.3	171.8	5.5	Dec. "	172.5	172.9	−.4
Dec. "	199.3	191.0	8.3	June 1925	173.5	173.8	−.3
June 1920	216.5	208.8	7.7	Dec. "	177.9	177.9	0
Dec. "	200.4	196.4	4.0	June 1926	174.8	174.8	0
May 1921	180.4	179.1	1.3	Dec. "	175.6	175.6	0
Sept. "	177.3	176.5	.8	June 1927	173.4	173.3	.1
Dec. "	174.3	174.1	.2	Dec. "	172.0	172.0	0
Mar. 1922	166.9	167.4	−.5	June 1928	170.0	169.9	.1
July "	166.4	167.0	−.6	Dec. "	171.3	171.1	.2
Sept. "	166.3	167.0	−.7	June 1929	170.2	169.9	.3
Dec. "	169.5	169.8	−.3	Dec. "	171.4	170.8	.6
Mar. 1923	168.8	169.1	−.3	June 1930	166.6	165.4	1.2
June "	169.7	170.0	−.3	Dec. "	160.7	161.0	−.3

In the Bureau of Labor Statistics Index, however, startling changes occur. Table III shows the practical importance of substituting an adjusted index when considering war and early post-war years. While many figures are only slightly modified, from 1917 to 1920 the change is enough to raise materially any such series as those of real wages and real earnings, and distortion is again having appreciable effect although not so pronounced as in the early post-war years. The adjusted series is constructed on the hypothesis that the simple average of the indices for December, 1917, and December, 1918, represents the

average price situation during the investigation period, since the end of the year of budget records varied between August, 1918, and February, 1919. That is, percentages in column (b) in Table II have been substituted as weights for those in column (c).

Adjustment of weights would have different effects on the Bureau's cost of living indices for different cities. Thus, for Baltimore the maximum subtracted is 9.4 in the index for December, 1918, while recent figures are little changed. For Boston the maximum is 8.8 for June, 1920, recent figures being lowered by about 2½ units.

The assumption that the simple averages of price indices for December, 1917, and December, 1918, are typical of the investigation period can hardly be exactly correct, so it is possible that the adjustment here made should be improved upon. But unpublished data would be necessary for this, and in view of (1) the rapid change in prices during the 1917–1919 investigation, (2) the twelve-month interval between price quotations before 1919, and (3) the variation in date of the collected budgets, there is doubt whether more complex adjustment would produce appreciable improvement. Until a new investigation makes backward calculation possible, we must probably accept inability to establish precision to a unit in the figures for 1916 to 1921, while in no case is precision of the first decimal place established. Use of weights adjusted from the 1901 investigation would produce even greater modification in the Bureau's series, the figure for December, 1919, becoming another unit lower and the most recent figures three more units lower.

No doubt seems possible but that the series here proposed has much better justification than the present official series; therefore substitution of this or of some similar modification of the Bureau's index is important in all analysis which extends backward beyond 1922.[1]

[1] Professor Paul H. Douglas, in *Real Wages in the United States*, has attempted revision of the official index for such analysis, but he, like the Bureau, omits to adjust the 1917–1919 expenditure distribution for price changes since 1913. Moreover, both of the modifications which he does make, which result in an index for the exact aggregate of the reporting cities, arise from oversight of the fact that no interest attaches to an aggregate of those cities for themselves, and that price quotations are gathered from them merely as representative of all cities in the country in the absence of a more extensive reporting system.

When in one modification he refuses to use the broader-based expenditure weights because he cannot obtain equally broad-based price indices, he rejects half a loaf in favor of no bread. Then the other modification, which weights the city indices by their population, gives greatly exaggerated importance to the largest cities and much too little importance to small cities. For all the 12 cities of over 500,000 in 1920 are represented in the reports, while only 7 out of 43 with populations of 100,000 to 500,000, and only 4 out of 76 with populations of 50,000 to 100,000, are represented. Moreover, if the index is supposed to represent urban communities in general (and it is so used) then the 4 cities with less than 100,000 have to represent also over 600 cities with 10,000 to 50,000 and over 700 with 5,000 to 10,000 population.

The result of his procedure is a series which from this analysis appears from 1917 onward to be consistently too high by from 3 to 11 units (on a 1913 base) all real-wage series being correspondingly too low. It is also very probable that the series for pre-war years rises too rapidly on account of the absence of rent, which is a relatively stable item of expenditure.

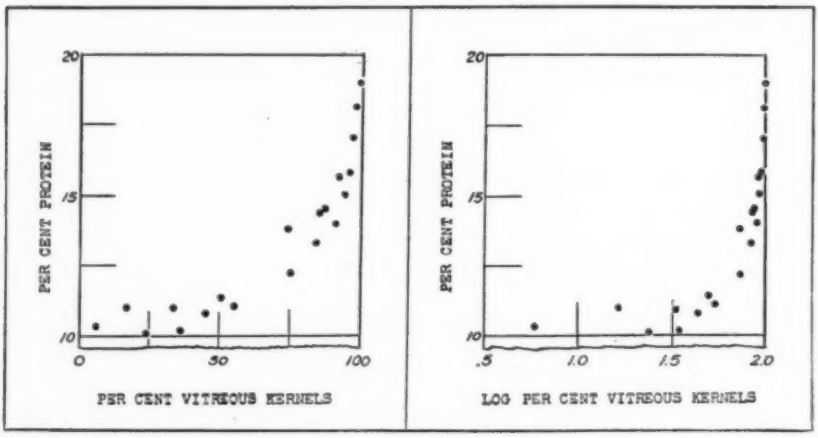
ALTERNATIVE STATEMENTS OF PERCENTAGE DATA IN THE FITTING OF LOGARITHMIC CURVES

By Frederick F. Stephan, *University of Pittsburgh*

In some cases logarithmic curves can be fitted successfully to distributions of percentage data only when a certain alternative statement of the data is employed. The alternative consists of presenting "per cent of A" in the sample or total in the equivalent form "per cent of not-A." For example, data on the per cent of the population of a city that is foreign born may also be stated as per cent of the population that is native born. Each actual percentage is subtracted from 100 per cent to provide the new percentages for the restated variable. If one such datum is "23 per cent foreign born" the datum restated is "77 per cent native born." This simple alternative is usually quite as reason-

CHART I

COMPARISON OF ARITHMETIC AND SEMI-LOGARITHMIC PLOTTING OF DATA REGARDING PROTEIN CONTENT AND VITREOUS KERNELS IN TWENTY SAMPLES OF WHEAT



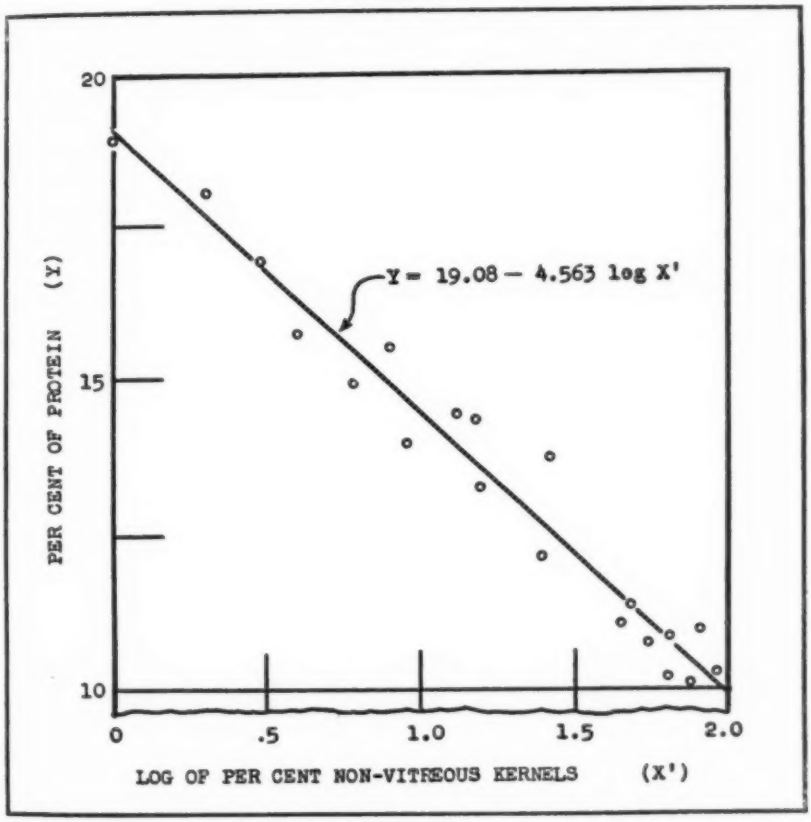
able a statement of the data as the one from which it was derived. It might very well have been chosen in the first place. It has no very important effect on the fitting of straight lines or parabolas of various degrees. The point of this note, however, is that in some cases of *logarithmic* curve fitting the second or alternate statement of the data is essential to success. A recent example of logarithmic curve fitting that proved unsatisfactory because the possibility of restating the data was overlooked illustrates the point. It will be shown below that

the same logarithmic curve fits the distribution very closely when the data are restated in the manner just suggested.

The problem referred to appears in Ezekiel's excellent treatise on *Methods of Correlation Analysis*.[1] Data are presented showing the per cent of protein (Y) and the per cent of dark vitreous kernels (X) found in twenty selected samples of wheat. The samples were "picked so as

CHART II

LINEAR DISTRIBUTION RESULTING FROM THE RESTATEMENT OF DATA SHOWN IN CHART I



to show the relationship more clearly. Actually the correlation is not so high as is shown by these selected cases."[2] A simple parabola, a cubic parabola, and curves involving the logarithms of X, of Y, and of both X and Y are fitted to the distribution. None of these attempts succeeds very well. Ezekiel states, "Of course, we might continue

[1] *Methods of Correlation Analysis*, by Mordecai Ezekiel. New York, John Wiley and Sons, 1930.
[2] *Ibid.*, page 71.

the process, using more and more complex equations, until finally we found one which did satisfactorily describe the relation. Or we might find that *no* ordinary mathematical expression would describe the relation. It might be that the underlying curve was so complex that it could not be represented in elementary algebraic terms."[1] He concludes that since the appropriate curve can only be found after a number of different curves have been tried and since it is only being sought for purposes of estimation, free-hand methods of fitting are probably as good as any. The writer agrees fully with that conclusion. He merely wishes to take this example from a very worthy treatment of curve fitting to illustrate the importance of the "reversibility" of percentage data when logarithms of the percentages are employed. He also wishes to show that when the data are given their alternative statement the above-quoted doubt that a simple mathematical expression can be found to fit the distribution closely proves groundless.

A comparison of the two distributions shown in Chart I makes it clear that the use of logarithms of the per cent of vitreous kernels only aggravates the problem of fitting a curve to the distribution. It suggests that the logarithms of the per cent of *non*-vitreous kernels might provide a better result. This actually proves to be the case as Chart II indicates. When the new distribution is plotted it appears to be quite linear. A straight line fitted to it by the method of least squares gives as the regression of per cent of protein (Y) on per cent of non-vitreous kernels (X'),

$$Y = 19.08 - 4.563 \log X'.$$

Ezekiel does not give the result obtained when he fitted the same type of equation to the original data but it may be calculated to be

$$Y = 2.50 + 6.25 \log X,$$

X being the percentage of vitreous kernels in the sample. The standard deviation of Y is 2.7 per cent. The standard error of estimate for the first equation is .53 per cent while that of the second is three times as great, 1.87 per cent. The respective coefficients of correlation are $-.98$ and $+.73$. The second equation is, as Ezekiel states, clearly inferior to the simple parabola. It may be added that it is also a poorer fitting curve than the simple straight line. The first equation, determined from the restated data, not only fits the distribution well but does so with a slightly smaller standard error of estimate than Ezekiel's final free-hand curve drawn without any hampering mathematical

[1] *Methods of Correlation Analysis*, by Mordecai Ezekiel, page 89. New York, John Wiley and Sons, 1930.

limitations. While the free-hand curve is still to be preferred for many reasons, the restatement of the percentages in alternate form makes possible an equally good fit by a simple mathematical expression. The result is unexpected when possibilities of a simple transformation of the percentage data are overlooked.

The result secured in this illustrative case is not hard to explain. Logarithms can be used with advantage to straighten out distributions only when the distribution "sags" toward low values of the variable in question. In the case just examined the data "bulge" away from low values and the use of logarithms only increases this "bulging." The "reversibility" of data expressed in percentages makes possible its restatement in such form that it "sags" in the necessary direction and straightens out partially or completely when plotted with the logarithms of the new percentages. It is possible to treat other types of data in similar fashion but in the case of percentages no violence is done to the common-sense meaning of the variable when the alternative statement is derived from it. Hence percentage data should always be scrutinized and restated if necessary before logarithmic curves are fitted to them.

EXTENSION OF FISHER'S FORMULA NUMBER 353 TO THREE OR MORE VARIABLES

By J. K. Wiśniewski

Aside from the strong economic background underlying Irving Fisher's work on index numbers (especially *The Making of Index Numbers*), his two basic tests and their application might be conceived in a quite axiomatic fashion. Fisher pronounces two axioms:

(1) *The time-reversal test:* The product of an index number P_{10} (or Q_{10}) by its time reciprocal P_{01} (or Q_{01}) should equal 1;

(2) *The factor-reversal test:* The product of an index number of prices P_{10} by the corresponding index number of quantities Q_{10} (which we will call the factor reciprocal of the former) should be equal to V_{10}, the index number of values;

and states two definitions, namely that of a time reciprocal and factor reciprocal for a given index number.[1] All the remaining work (Chapters IV to VII of *The Making of Index Numbers*) is purely formal algebra. The "ideal" formula is reached by starting from two formulas (Laspeyres' and Paasche's) which seem more plausible than any others.

The purpose of this paper is to show how Fisher's treatment can be extended to n variables, instead of two only (prices and quantities).[2]

I. The time-reversal test, referred to as axiom (1), and the definition of time reciprocal remain unchanged.

II. Before we attempt to restate the second axiom and the corresponding definition we shall fix for a moment our attention upon the notation used, which will necessarily become to a certain degree complex. The data determining a given index number differ *inter se* for the following reasons: (a) As to the variable, such as price, quantity, etc., those variables will be distinguished by means of subscripts; (b) as to the period—we shall consider two periods only, viz. 0 and 1—the appropriate figure in each case will be put in parentheses; (c) as to the item—such as individual commodities in an index number of prices. Since the index number formulas cover, as a rule, all such items within the scope of the given study, we shall not employ any special symbols to identify different items. Thus $x_k(0)$ will mean the value of the variable x_k for the period 0 for any item; $I_{10}(x_k)$ will mean the index number of the variable x_k in the period 1, period 0 being taken as a base; I' will

[1] I do not mean by this that there are no other axioms and definitions used in Fisher's work. Those stated above are essential and peculiar to it.

[2] The possibility of such an extension is admitted by Professor Fisher himself on page 381 of the quoted book.

be used to denote an index number satisfying the time-reversal test; I'' an index number satisfying both tests. For convenience we assume that the correction with respect to the time-reversal test is always made first. And V_{10} is understood to equal

$$\frac{\Sigma x_1\,(1)\cdot x_2\,(1)\ldots\ldots x_n\,(1)}{\Sigma x_1\,(0)\cdot x_2\,(0)\ldots\ldots x_n\,(0)},$$

the summation being extended to all the items (that is to all the *commodities*, in the ordinary case of the two variables price and quantity).

Now we pronounce the following axiom, which corresponds to axiom (2) for two variables:

(3) Every index number formula should satisfy the following identity $\prod_{i=1}^{n} I''_{10}\,(x_i) = V_{10}$ or, verbally, the product of an index number and all its factor reciprocals should equal the index number of "value."

This is fulfilled if[1]

$$I''_{10}(x_k) = \sqrt[n(n-1)]{[I'_{10}(x_k)]^n \frac{V^{n-1}}{\prod_{i=1}^{n} I'_{10}(x_i)}}. \tag{4}$$

If we only require the factor-reversal test to be fulfilled, I' in (4) may be any index number. If I' satisfies the time-reversal test, then I'' defined by (4) will satisfy both tests.

Therefore the only remaining problem is: Having $I'_{10}\,(x_k)$ define $I'_{10}(x_l)$ $k \neq l$. This is a generalization of the two variable problem: Having defined a price index how can we define a quantity index—in other words, it is the general problem of defining a factor reciprocal.

Now we see that:

(5) Any index number formula, $I'_{10}\,(x_k)$ for instance, may be conceived quite generally as a function of the several x's taken for some or all items, for the variables x_1, $x_2 \ldots x_n$, and for the periods 0 and 1.

This being so we define:

(6) For a given $I'_{10}\,(x_k)$ the corresponding $I'_{10}\,(x_l)$ is equal to a function of the same form as $I'_{10}\,(x_k)$, where, however, the x_k's are replaced by x_l's taken for the same periods as the x_k's have been, and the x_l's are replaced by the x_k's taken for the same periods as the x_l's have been taken in $I'_{10}\,(x_k)$. All other ex-

[1] Equation (4) is not the only possible way of fulfilling (3). We select it, however, because of its relative simplicity and symmetry; thus we introduce a complementary axiom, just as Fisher does. The word "value" above is put into quotes because the discussion up to the present point is purely formal and there is no specific meaning attached to the individual variables.

pressions $x_1, x_2 \ldots x_k-1, x_k+1 \ldots x_l-1, x_l+1 \ldots x_n-1, x_n$ remain unchanged.

So (5), together with (6), gives the desired definition of a factor reciprocal of a given index number. It should be kept in mind that any index number has n-1 factor reciprocals within a system of n variables.

III. Thus having stated the general conditions for any number of variables we can proceed to a more concrete and limited problem. Suppose we have only 3 variables denoted, for simplicity, p, q, r. Then P, Q, R will be the respective index numbers, the periods being identified by subscripts. In order better to visualize the system we may assume that p represents prices of certain crops, q crop areas, r yield per acre, V is then an index number of value.

Let us start with the formula $P_{10}=\frac{\Sigma p_1 q_0 r_0}{\Sigma p_0 q_0 r_0}$ analogous to that of Laspeyres.

Correcting with respect to the time-reversal test, we get

$$P'_{10}=\sqrt{\frac{\Sigma p_1 q_0 r_0}{\Sigma p_0 q_0 r_0}\cdot\frac{\Sigma p_1 q_1 r_1}{\Sigma p_0 q_1 r_1}}. \tag{7}$$

Evidently (3) becomes $P''_{10}\cdot Q''_{10}\cdot R''_{10}=V_{10}$ and (4) becomes

$$P''_{10}=\sqrt[6]{P'^2_{10}\,\frac{V^2_{10}}{Q'_{10}\cdot R'_{10}}}.$$

By (5) and (6) we find easily

$$Q'_{10}=\sqrt{\frac{\Sigma p_0 q_1 r_0}{\Sigma p_0 q_0 r_0}\cdot\frac{\Sigma p_1 q_1 r_1}{\Sigma p_1 q_0 r_1}} \qquad \text{and} \tag{8}$$

$$R'_{10}=\sqrt{\frac{\Sigma p_0 q_0 r_1}{\Sigma p_0 q_0 r_0}\cdot\frac{\Sigma p_1 q_1 r_1}{\Sigma p_1 q_1 r_0}} \qquad \text{thus} \tag{9}$$

$$P''_{10}=\sqrt[12]{\frac{(\Sigma p_1 q_1 r_1)^4\,(\Sigma p_1 q_0 r_0)^2\,\Sigma p_1 q_0 r_1\,\Sigma p_1 q_1 r_0}{(\Sigma p_0 q_0 r_0)^4\,(\Sigma p_0 q_1 r_1)^2\,\Sigma p_0 q_1 r_0\,\Sigma p_0 q_0 r_1}}. \tag{10}$$

It is to be noted that we get the same final expression for P''_{10} whether we start from $P_{10}=\frac{\Sigma p_1 q_0 r_0}{\Sigma p_0 q_0 r_0}$, $P_{10}=\frac{\Sigma p_1 q_1 r_0}{\Sigma p_0 q_1 r_0}$, $P_{10}=\frac{\Sigma p_1 q_0 r_1}{\Sigma p_0 q_0 r_1}$, or $P_{10}=\frac{\Sigma p_1 q_1 r_1}{\Sigma p_0 q_1 r_1}$. Analogous formulas may be developed for Q''_{10} and R''_{10}. We suppose that formula (10) may be called the "ideal index number for three variables" as justly as Fisher's No. 353 is called "ideal" for the case of two.

IV. *Numerical example.* Let us take p, q, r as assumed in section

III, let the periods under consideration be 0 = 1927 and 1 = 1928 and the items in question—wheat, corn, oats and barley. Source of data: *Yearbook of Agriculture*, 1928, Tables 1, 45, 65 and 79. The data taken are either totals or averages for the United States.

Crop	Price (cents per bushel)		Area harvested (thousands of acres)		Yield (bushels per acre)	
	1927	1928	1927	1928	1927	1928
	p_0	p_1	q_0	q_1	r_0	r_1
Wheat	111.5	97.2	58784	57724	14.9	15.6
Corn	72.3	75.1	98393	100761	28.1	28.2
Oats	45.0	40.9	41941	41733	28.2	34.7
Barley	67.8	55.2	9476	12539	28.1	28.5

$P''_{10} = 98.60$; $Q''_{10} = 101.61$; $R''_{10} = 102.80$; $V_{10} = 102.99$.

The above index numbers enable us to analyze the growth of crop value from 1927 to 1928; we see the contribution of prices, area harvested and yield.

CHARTS AND MAPS OF THE SOCIAL AND ECONOMIC MUSEUM OF VIENNA

Visitors to Vienna may remember the Social and Economic Museum located in the beautiful municipal hall. The object of this little museum is to familiarize, by means of colored symbols, the man in the street with the statistical results of the social and economic development of the world. The "Vienna method" consists in replacing the statistical figures by symbols which represent a given quantity of men, raw materials, machines, etc. In order, say, to compare the population of two countries, one of which has 5 million and the other 50 million inhabitants, the first country is represented by one person and the second by 10 persons. This method is certainly much more illuminating than the usual way of representing the first country by a little man and the second by a tall man.

There exists already ample literature on the achievements of the museum, and many charts have been reproduced in pamphlets, magazines, etc. But no description and no small-size reproduction can convey an adequate idea of the high artistic and pedagogical value of the original charts. It is therefore most gratifying that the museum has now published an extensive collection of large maps and charts which by themselves practically constitute a museum. The collection comprises 31 charts about the most important empires during the last 5,000 years, about armies, wars, and forms of government; 33 charts about production, consumption, commerce and traffic; 12 charts about population and housing; 17 charts about labor, organization, and social conditions; 6 charts about economic systems and religions; and in addition 30 sheets of explanatory text and tables. The price of the series published by the Bibliographisches Institut in Leipsig is 65 Rm.

There is perhaps no other publication in the world which is so well fitted to teach economic and social history to the untrained mind. But even expert economists and sociologists will find therein a mine of information.

R. R. KUCZYNSKI

WHAT STOCK GROUPS WILL LEAD THE NEXT BULL MARKET?

A dinner meeting of the American Statistical Association was held on Tuesday evening, November 18, 1930, at the Aldine Club, 200 Fifth Avenue, New York City. Five hundred and thirty-one persons attended. The general topic under discussion was, "What Stock Groups Will Lead the Next Bull Market?" Mr. Robert B. Warren, of Case, Pomeroy, and Company, presided.

The first speaker of the evening was Mr. Mark Wolff, statistician of Hamershlag, Borg and Company. He opened by expressing the view that, to a greater extent than in the recent past, stock values in the next few years will be correlated more closely with income accounts and balance sheets, and less closely with traditional market popularity. He then took up the consideration of specific groups of stocks. In discussing public utilities, he called attention to the fact that the influence of regulation was largely overlooked during the last boom. As a matter of fact, regulation has been lax for several years past. At present, however, there is a distinct tendency toward greater strictness.

While, for public utility stocks, the average ratio of price to earnings has declined from approximately 36 to around 15, the present ratio is by no means low, for if the companies should pay out 75 per cent of their earnings in the form of dividends, the yield would still be but 5 per cent. Furthermore, there is little reason to anticipate a sharp upward trend in public utility earnings except, perhaps, in the case of some natural gas companies.

The railroad stocks were not leaders in the last "bull market" and have since declined sharply. One must not overlook the fact that the volume of railway traffic is being steadily cut into by the competition of canals, ships, trucks, buses, pipe lines, and electric power lines. The Interstate Commerce Commission can be expected to keep earnings from rising sharply, but that body cannot be depended upon to insure increases in earnings. Under such circumstances, it appears that the railroad and traction stocks should sell at ratios of price to earnings lower than those pertaining to industrial stocks. At present, however, the ratio for railroad stocks is the higher. This fact prevents the outlook for these classes of stocks from being favorable.

The fact that industrial concerns are unregulated, gives them a distinct advantage. At present, price-earnings ratios in this field are relatively low. Some department and chain stores are lopping off unprofitable units and cutting expenses. With a steadily growing patronage, their profits should increase. Food manufacturing concerns are faring better in 1930 than in 1929. Business in this line appears to be gravitating in the direction of those concerns advertising nationally. The outlook for these companies appears, therefore, to be favorable. The production of nickel, lead, and aluminum is almost monopolized by a few concerns. Important new uses for these metals in construction and electrical work point to a growing demand. This situation should be favorable for these industries. Sales of automobile tires have been low for several months past. Even though tire durability is increasing, the probabilities are that the proportion of tires badly worn is now unusually large. Rubber seems to be at or near bottom prices. It appears, therefore, that the companies manufacturing tires for replacement purposes are in an advantageous position. The shares of bank and trust companies cannot be looked upon with great favor in a period in which interest rates, and hence earnings, are low. Fire insurance companies must be thought of as largely in the nature of investment trusts, for they have large holdings of stocks of other concerns. The fact that they have invested most extensively in railroad and public utility stocks makes their outlook none too promising. The stocks of fixed investment trusts are also unattractive, for the holdings of such trusts consist largely of "blue chip" issues, and besides, the market prices of such fixed trust shares include a premium above liquidating value. On the other hand, the shares of the better management trusts may be looked upon with favor because of the fact that they are selling on the average about 30 per cent below break-up values.

The second speaker was Professor A. M. Sakolski of the College of the City of New York. He began by warning those who looked for prompt recovery in stock prices that depressions in stock markets sometimes last for long periods. In 1857, one continued for three years. The dip beginning in 1869 did not

terminate until 1877. The recovery from the decline of 1891 and 1892 was not complete until 1896. On the other hand, it must be admitted that recent major swings have usually been shorter than those just referred to. As the course of the stock market is dependent upon politics as well as business, it is very difficult to forecast.

Some stock groups which formerly were of great importance appear to be passing out of the picture. One such group consists of traction stocks. Because of government regulations, rail stocks have lost their romance. Many believe that they also are passing out of the field of activity. It is well, however, to remember that railroads still show marked earning capacity and that the public is now more interested in investment than in speculation. It is, therefore, by no means impossible that railroad stocks may be leaders in the next advance.

What has been said of railroad stocks applies largely to bank and insurance stocks. The services of these concerns are likely always to be in demand. Hence, there will always be a market for their stocks.

The profits of many industrial concerns vary directly with the prices of the semi-manufactured materials which they produce. At present, materials such as copper are extremely low. An advance in these material prices will mean prosperity for companies of the class mentioned.

The third speaker was Mr. Leroy D. Peavey, President of Babson's Statistical Organization. He pointed out that, when predicting the future, one must always insert the reservation, "wars or startling new inventions not occurring," for we have not yet learned to predict these events.

It seems reasonably certain that the American scale of living will keep on rising for some time to come. Chemistry is contributing greatly to the advance of our national productivity. Most of the concerns in the field are not curtailing their research activity during the present depression. Among other things, new uses for cellulose appear to offer great possibilities.

We may look for marked increases in the demand for things ministering to comfort. Better housing and better household equipment will be demanded. The cooling, as well as the heating, of houses is almost sure to develop. When it does, the gas and electric industries will benefit. The extensive development of pipe lines is putting to use a vast amount of natural gas formerly wasted.

The tendency toward smaller families, smaller apartments and more wives gainfully occupied is leading to a greater demand for prepared food. Branded goods put up in sanitary, attractive packages are gaining favor. The quick freezing process offers promising possibilities. Dairy products are constantly growing in popularity.

Companies manufacturing electrical equipment may be expected to benefit, not only from the growing demand for improved household devices, but also from the electrification of railways. Everywhere we find a demand for speed. This calls for more electric power. It also means that aircraft will forge ahead rapidly as soon as this form of transportation is made safe. The automobile companies are using all possible means to encourage the building of better highways, and better highways mean business for manufacturers of highway materials such as cement and asphalt.

Progress of our Nation is becoming a study in geometric progression. Intensive thought is being applied to economic problems through modern research laboratories. They are the sources of agencies which will be very prominent in our next prosperity.

Mr. Peavey said that it is not a necessary deduction that great profits in each case will at once accompany the physical expansion of the industry. There is often a lag between the real growth of an industry and the market profits that accrue to investors.

The fourth speaker was Mr. Karl G. Karsten, Director of the Karsten Statistical Laboratory. He pointed out that his method of attacking the problem under consideration was radically different from those of the other speakers, being engineering, rather than philosophical in its technique. Recently, his energy has been devoted to studying the forces influencing events only two or three months ahead.

Mr. Karsten suggested that the problem facing statisticians and economists today is very similar to that which confronted astronomers many decades ago, when they were called upon to construct tide tables for the various ports of the world. The problem of the astronomer was solved by the construction of an intricate machine which solved equations. The various factors influencing the tide are now set on different dials on the machine. The crank is rotated and the height of the tide at any given instant at the given place is indicated on a scale. In the future, similarly, the statistician will set on different dials the status of various economic forces, will turn the crank, and read off the resulting situation for some date several weeks or months ahead. The Karsten Statistical Laboratory has already devised a mechanical system which indicates what the relative position of certain leading industries will probably be during the next two or three months.

Slides were projected on the screen showing that the method of forecasting had worked very successfully regarding certain industries during the last three years. The prediction was made, that, during the next thirty days, as compared to the market as a whole, public utilities would be decidedly strong, steel stocks fairly strong, motor stocks about average, store stocks weak, and oils very weak.

The last regular speaker on the program was Professor Lewis H. Haney, Director of the Bureau of Business Research, New York University. He began by stating that it is difficult to make a forecast for a period running more than six months ahead, and he had little expectation that the next "bull market" would get well under way within that interval of time. The basis for prediction concerning the future is the existing situation as regards operating expenses, sales outlook, balance sheets, etc. At present, concerns dealing in tobacco, food, dairy products, drugs, agricultural machinery, manufacturers of ships and electrical equipment, and operators of some chain stores hold the strongest positions.

The increasing use of nickel, of the lighter metals, and of rust-proof iron and steel is likely to be of importance in determining the future course of the market. Important developments are also taking place in the field of chemistry and the development of electrical devices. The prospects for multi-lingual films seem

good. Natural gas is becoming more important than formerly. There are strong possibilities that improved methods of marketing will be helpful to certain concerns.

The existing shortage of automobile tires, certain classes of meat products, and cotton textiles must also be taken into consideration. However, cotton textiles have many rivals; hence, their future may not be assured. The outlook for extensive road building is also favorable to companies contributing to this line.

Professor Haney felt that market popularity is largely made by the actions of operators, and that these leading operators tend to deal in the same stocks year after year. It is, therefore, considered not improbable that old market leaders will again be in the forefront during the next rise, provided that they can be secured at prices having a reasonable relationship to earnings.

In selecting stocks at present, investors will, if wise, choose the low-cost companies in each field, those that are producing at the least operating expense per unit. Stocks of specific concerns which he mentioned as being especially promising were: General Foods Corporation, Drug, Inc., Continental Can Company, Inland Steel Company, Standard Oil Company of New Jersey, Timken Roller-Bearing Company, Paramount Publix, International Nickel Company.

Mr. A. W. Zelomek, Statistician-Economist of Fairchild Publications Company, and Borsodi Analytical Bureau, summarized the discussions of the various speakers, pointing out in what respects they agreed and in what ones they were in variance. Mr. Zelomek ventured the opinion that the "bear market" would be over within six months, and that industries providing the essentials of life—food, clothing, and shelter—would lead the next advance. He believed the textile industries to be in a favorable position because of the very low prices of raw materials prevailing and because of the small inventories now on hand. On the other hand, he saw little future for the department store or the chain store, believing that both of these groups were now meeting competition from organized independent stores which it would be very difficult to overcome.

WILLFORD I. KING, *Secretary*

PROGRESS OF WORK IN THE CENSUS BUREAU

PUBLICATION OF THE RESULTS OF THE POPULATION CENSUS

The statement of the final population of the several states exclusive of Indians not taxed, which under the law regarding the apportionment of Representatives, must be transmitted to Congress by the President within one week after Congress meets, was ready for transmission on November 22 together with tables showing the apportionment of Representatives by the different methods as required by the law, and was transmitted to Congress on December 5. Unless Congress amends or repeals the law at this present session, which seems very unlikely, this apportionment will go into effect.

The first series of state bulletins giving the population of cities, counties, townships, precincts, and other civil divisions has been completed and published,

REAPPORTIONMENT[1] OF THE PRESENT NUMBER OF REPRESENTATIVES (435) ON THE BASIS OF THE CENSUS OF 1930 AS REQUIRED BY THE ACT OF JUNE 18, 1929

State	Number of representatives				State	Number of representatives			
	Present house	House as reapportioned on basis of 1930 Census				Present house	House as reapportioned on basis of 1930 Census		
Total	435	435	Gain	Loss				Gain	Loss
Alabama	10	9	..	1	Nebraska	6	5	..	1
Arizona	1	1	..	..	Nevada	1	1	..	..
Arkansas	7	7	..	..	New Hampshire	2	2	..	..
California	11	20	9	..	New Jersey	12	14	2	..
Colorado	4	4	..	..	New Mexico	1	1	..	..
Connecticut	5	6	1	..	New York	43	45	2	..
Delaware	1	1	..	..	North Carolina	10	11	1	..
Florida	4	5	1	..	North Dakota	3	2	..	1
Georgia	12	10	..	2	Ohio	22	24	2	..
Idaho	2	2	..	..	Oklahoma	8	9	1	..
Illinois	27	27	..	..	Oregon	3	3	..	..
Indiana	13	12	..	1	Pennsylvania	36	34	..	2
Iowa	11	9	..	2	Rhode Island	3	2	..	1
Kansas	8	7	..	1	South Carolina	7	6	..	1
Kentucky	11	9	..	2	South Dakota	3	2	..	1
Louisiana	8	8	..	..	Tennessee	10	9	..	1
Maine	4	3	..	1	Texas	18	21	3	..
Maryland	6	6	..	..	Utah	2	2	..	..
Massachusetts	16	15	..	1	Vermont	2	1	..	1
Michigan	13	17	4	..	Virginia	10	9	..	1
Minnesota	10	9	..	1	Washington	5	6	1	..
Mississippi	8	7	..	1	West Virginia	6	6	..	..
Missouri	16	13	..	3	Wisconsin	11	10	..	1
Montana	2	2	..	..	Wyoming	1	1	..	..

[1] The first Congress apportioned on the basis of the Census of 1930 will be the Seventy-third, to be elected in 1932.

the last issue of the series, that for the state of New York, being received from the printer on December 28. A United States Summary bulletin, giving the population of each state and county, and of each city of over 1,000 population, the cities being grouped according to size, has also been issued. These first-series bulletins are being bound up together, to form the first volume of the 1930 census reports on population.

The second series of state bulletins for population, under the title, "Composition and Characteristics of the Population," will give the classification by color, nativity, sex, age, school attendance, illiteracy, and marital condition, and also the classification of the foreign-born white population by citizenship, distinguishing naturalized, having first papers, and alien. These bulletins will also present the number of gainful workers, classified by industry groups showing about 50 groups for the state as a whole and a condensed list of about 30 groups for the counties and larger cities. Occupation data have not been presented by counties in any recent census. Bulletins for 5 states in this second series have thus far been published, and it is expected that the series may be completed by the end of July.

Another new feature in the census tabulation is a presentation of statistics in some detail by townships or other minor civil divisions. The population classification presented for these small areas will show sex, color (white or Negro), general nativity, eight age classes, and the rural-farm population. These details

will be shown for each town, township, precinct, district, militia district, ward, beat, or whatever the designation of the minor civil division may be. As there are about 80,000 of these minor civil divisions in the United States, it can readily be seen that this tabulation will add very greatly to the size and detail of the census reports as compared with prior censuses. Moreover, there will be a similar township classification for the census of agriculture, showing total number of farms, total acreage, acreage of each of eight classes of farm land, also farm values, distinguishing the value of farm buildings, of farmers' dwellings, and of farm implements and machinery.

THE TABULATION OF THE POPULATION CENSUS

The individual cards, numbering over 122,000,000, have all been punched and are being run through the tabulating machines. Also the cards for the unemployment returns of last April. The family card, recording the data for each individual family, has been designed and printed and is being punched.

The scheme runs or counts for the individual population cards are as follows:

In the first count the cards are run through the tabulating machine by enumeration districts, these districts being small areas with a population usually less than 2,000. In this count the population is classified by sex, by color and nativity, by age, and as farm-resident and nonfarm-resident. The results are published by townships and for the smaller incorporated places, rather than by enumeration districts.

For the next three counts the cards are consolidated into a geographic arrangement which comprises cities of 50,000 or over by wards or tracts, cities and other urban places of 2,500 to 50,000, each place separately, and the rural part of each county, which is further separated into rural-farm and rural-nonfarm.

The cards for each of these geographic areas are sorted by sex and color, the cards for the white population are further sorted by nativity, and for the native whites, by parentage, giving potentially five groups (native white of native parentage; native white of foreign or mixed parentage; foreign-born white; Negro; and other colored) for the males, and five similar groups for the females.

In the second count the cards, sorted as indicated above, are tabulated by age (under 1 year; 5-year groups up to 34; and 10-year groups from 35 to 74); by illiteracy and school attendance, with special age groups for these subjects; and by marital condition.

The third count classifies the foreign-born whites, male and female, by country of birth and citizenship, and the native whites of foreign or mixed parentage by country of birth of parents. The latter classification is made on the basis of country of birth of father, except for native whites having father native and mother foreign, who are classified according to country of birth of mother.

The fourth count covers gainful workers 10 years of age and over, classified as male and female (and also, for the southern states, as white and colored). These gainful workers are separated into about fifty industry groups. Some of these groups, like agriculture, shoe factories, cotton mills, and steam railroads, are definite and clearly defined; other groups are of necessity made up of combinations of related industries.

Upon the completion of the fourth count a further geographic consolidation is made, resulting in the following areas: Each city of 25,000 and over separately; all urban places of 10,000 to 25,000 in the state combined; all urban places of 2,500 to 10,000 combined; the rural-farm population of the state; the rural-nonfarm population of the state.

For the fifth and sixth counts the cards for white males and females of foreign birth or parentage are sorted by country of birth or country of birth of parents. In the fifth count the cards for foreign-born whites are tabulated by citizenship, in two age groups, under and over 21, and by mother tongue.

In the sixth count the cards for foreign-born whites are tabulated by marital condition, by age in combination with literacy and ability to speak English, and by year of immigration. In the same count the cards for the native whites of foreign or mixed parentage are tabulated by marital condition, by specific parentage groups (distinguishing those with both parents foreign, those having father foreign and mother native, or mother foreign and father native), and by age in combination with literacy.

The seventh count is made for the five color-nativity groups by sex, and gives single years of age from 1 to 99; literacy and school attendance by single years of age up to 34, then by 5-year periods; marital condition with the same age classification; and the details of parentage.

The eighth count classifies the several native classes by state of birth.

Additional counts will be made, giving the classification of the gainful workers by occupation as well as by industry.

The first four counts, as above described, are practically completed and furnish the data which is being published in the second series of state bulletins, referred to above, on composition and characteristics of the population.

THE ATLANTA CASE

The court refused to grant the petition for the injunction referred to in the last issue of this JOURNAL. The parties concerned, representing the city of Atlanta and certain private corporations in that city, then took an appeal from the earlier decision of the court refusing to grant the writ of mandamus originally asked for. This appeal at this writing is still pending but will probably be heard and decided before this issue of the JOURNAL is in print.

J. A. H.

MISCELLANEOUS NOTES

The Austin (Texas) Chapter.—The Austin Chapter held a meeting on October 29, 1930, with fifty persons present. Mr. Carl H. Robinson, Chief Statistician for Texas of the United States Bureau of Agricultural Economics, spoke on "Forecasting Crop Yields from Line of Best Fit Instead of Par Line." Mr. Robinson illustrated his discussion with charts actually used for most of the principal crops of Texas.

The Boston Chapter.—A joint meeting of the Boston Chapters of the American Statistical Association and the National Association of Cost Accountants was held at the Boston City Club on Friday evening, December 12, 1930. Dinner was served at 6.30 P.M. There were 117 members and guests present at the dinner and about 180 at the speaking session.

Mr. Charles H. Cornell, President of the Boston Chapter of the American Association of Cost Accountants, presided, and Dr. Davis R. Dewey, President of the Boston Chapter of the American Statistical Association, introduced the speakers.

Mr. Joseph H. Barber, Assistant to the President of the Walworth Company, Boston, was the first speaker, and the subject of his address was "How the Walworth Company Forecasts Its Program for 1931." He discussed the methods by which his company arrives at its forecasts for its particular business, so that it may adjust its operating programs accordingly. In part, he spoke as follows:

"We have found it necessary to dig deeper than the cautiously worded general forecasts for 'average business' which are available in profusion from the so-called economic surveys and in the daily press. These we have found wanting in definiteness when it comes to interpreting them into specific plans. We hesitate to repose confidence in anything but demonstrated natural relationships between cause and effect. Our philosophy depends upon a major belief that the rise and fall of any business as an individual economic unit has some very definite relation to the rise and fall of other closely allied economic units.

"We have searched out what economic trends affect us directly and in what approximate proportions; and we have constructed an economic index so as to reflect a summary of these conditions continuously. Specifically, we have compiled for ourselves a monthly rate of ordering in those basic industries that parallel our own and that consequently reflected the same economic conditions as those to which we are subjected. The development of a very close correlation argues that our orders have varied when they have because, on the average, the industries that have given us our orders have varied that way.

"We attach great value to the fact that we can now trace from effects back to causes. Since we know the several elements of the index, we can pick it apart in a way we cannot analyze our own total order curve. We can study the separate economic elements, arrive at a separate conclusion for each, and then estimate the net result of all upon our own developing order trend. Whereupon we are in a position to adjust our sales strategy accordingly and figure how we ought to equalize our production against the measured demand."

Dr. Carl Snyder, Statistician of the Federal Reserve Bank of New York, discussed the topic, "The Relationships of Credit and Trade." A summary of his address follows:

"Now, just perhaps as the real turn is near, the hue of popular imagination abruptly changes. There is no longer any hope. Everything, we are cheerfully assured, is now on a permanently lower level; stocks and incomes and standards of living, com-

pany earnings and prices and all the like. Most serious predictions from most serious men! In other words, within a space of a year the public mind seems to have swung from one fantastic extreme to the other.

"Reading all this, what would an unprejudiced observer think of us as a people, or at least, the more vocal part of us; one year gulping credulously almost every kind of economic bunk and balderdash that could be invented, and the next year disillusioned, imagining that our long and steady advance to the industrial supremacy of the world, which had made this country the envy of all nations, had suddenly come to an end. Is it not grotesque?

"No decennium in more than a century, probably not even in the whole life of our republic, has failed to record an advance in our national product, therefore in our national income and well-being, not merely as a nation as a whole but per capita as well. For the past fifty years at least, years for which we have full and adequate information, this industrial advance has gone forward at an almost unchanging rate, compounded at close to four per cent a year. And there is little doubt that this was equally true of the half-century and more preceding this. Every era, if you please, has been in a sense a 'new' era, as far back as the record extends. But there seems little that was especially new in any one of them, and most particularly the 'new' era which came to such an untimely end in the popular imagination last year.

"In all this long period of national development we have had very considerable ups and downs, intervals of severe depression alternating with years of boom, some of them going to rather wide extremes in a sort of twenty or twenty-five-year cycle, as in the 80's and the early 1900's and the post-war period. The boom and panic of 1905–1907 and likewise that of the late 80's and '95 were so like our latest boom and panic that they differed, so to speak, only in dates, labels and trimmings.

"What possible reason for believing that all this has changed abruptly? It is certain that we have as yet clearly to understand the force of inertia or, if you please, the invariable concurrence of forces in our economic order. Consider that the far larger part of our immense industrial product is still for the immediate concern of livelihood, things to eat and wear, fuel for warmth and spectacles to enjoy. The flour mills, the coal mines are still running and ten or twenty thousand—heaven knows how many—places of amusement are still open and well patronized.

"With a number of others, I have sought to estimate how much our total national output as a whole is really reduced, even in so severe a depression as the present. There seems reason for believing that it is rarely, if ever, more than something like ten or twelve per cent decline from the levels of what we call high prosperity. Thus, for example, at the moment railroad traffic, measured in ton-miles and not in company profits, is something like twelve per cent below high levels of last year; and it is quite certain, I think, that this represents an extreme kind of measure of depression.

"So I have thought that if we were to draw a line representing what is called our normal curve of growth and measure the deviations from this steadily rising line, what we call high prosperity might run four or five per cent above this line for the nation taken as a whole, and what we call depression four or five per cent below. Scarcely more! In other words, I conceive that even at such severe times as this, which mean privation and distress for possibly several million workers, the business of the nation, the sum of its colossal effort, is still proceeding at something like ninety to ninety-five per cent, not of its maximum attainable product but at least of its normal average long-term of increase.

"The exaggerated ideas in this regard, which are quite prevalent, have, I believe, been engendered by seriously mis-branded measures of business and general trade."

By means of charts, Dr. Snyder showed the close correlation of the curves representing the trend of credit and trade since 1875, and suggested that it might be possible through a wise control of credit to maintain greater business stability.

Following the addresses there was a spirited discussion of the two addresses until adjournment at 10.25 P.M.

ROSWELL F. PHELPS, *Secretary*

Recent Activities of the Chicago Chapter.—The first meeting of the 1930–1931 season was a dinner meeting held on October 23. The speaker of the evening was Dr. Garfield V. Cox, Professor of Business Economics at the University of Chicago, and his topic was "The Business Outlook." The attendance was eighty.

In discussing the present outlook, Dr. Cox reviewed in some detail the factors suggesting an approach of the turning point. He also reviewed forecasts made in the first part of the year and their failure to foresee the acuteness of the depression which was under way.

In analyzing the reasons for the common over-optimism of these forecasts, he said that it was due less to overlooking factors of importance than to improper valuation of recognized influences. Among the factors that were under-weighted were: the foreign situation, inventories and the collapse of price stabilization schemes. The comparison with 1921 seemed all in favor of 1930. The "new era" doctrine of stabilization or, at least, decreasing severity of variations in business activity was more commonly accepted than most people realized. The sudden recovery in 1924 and the slightness of the recession in 1927 were sometimes accepted as proving these views.

Dr. Cox also stated that he believed the importance of the influence of installment selling in causing the accumulation of unpaid-for merchandise in the hands of consumers and in decreasing their ability to continue to purchase commodities was largely overlooked.

At a dinner meeting on November 20, Dr. Henry Schultz of the Department of Economics of the University of Chicago presented a paper on "Changes in Demand for Agricultural Commodities, 1875–1930." This paper was the outgrowth of intensive researches which Dr. Schultz has been carrying on into the changes in the responsiveness of demand to price variations of agricultural products. These studies were undertaken to determine, for selected agricultural commodities, the elasticity of demand, the annual rate of shift, and the per cent variance in consumption accounted for by each of the variables, price and time. The commodities selected for the study included: wheat, corn, hay, sugar, potatoes, oats, barley, rye and buckwheat.

In analyzing the relationship between price and demand, the three variables, per capita consumption, real or deflated price per unit, and time, were used. Dr. Schultz stated that it had been necessary in many cases to develop statistical methods and that, in part, the contribution being made by these studies was the special methods being developed to fit this type of analysis. He added that it was the hope of the small group of economists in the country engaged in research of this nature to contribute to or perhaps replace the accepted theoretical relationship of price and demand by mathematically determined relationships.

At a dinner meeting on December 11, Dr. David Friday of A. G. Becker and Company discussed "Foreign Affairs and the American Business Situation." Approximately one hundred were present at this meeting.

Dr. Friday briefly summarized the major foreign events that contributed to the

international business depression, of which the two major ones in his opinion were: the accumulation of immense gold reserves by the Bank of France, and the numerous attempts at price maintenance during recent years by private associations and governments. The Bank of France, he said, accumulated gold to aid in the rehabilitation of the country following the War, to stabilize the franc and in preparation for future refunding operations. This accumulation of gold has been at an annual rate in excess of world production and consequently led to depletion of reserves of other countries.

Attempts to maintain prices by private and governmental pools were considerably more numerous than was generally known a year ago. Although the high prices resulting from these pools did not in every instance lead to over-production, they did result in over-expansion of production facilities.

After reviewing the events which contributed to the depression, Dr. Friday discussed in some detail the factors which were slowly bringing about improvement.

A spirited discussion following Dr. Friday's address was led by Dr. George E. Putnam, Manager of the Commercial Research Department of Swift and Company.

The Pittsburgh Group.—A meeting of the Pittsburgh Branch was held on November 20. This meeting was attended by approximately thirty-five business men and statisticians in the city of Pittsburgh. The interest in the subject of "Business Conditions," which was the topic for discussion, was intense and all present endorsed the scheme whereby attempts will be made in the future to forecast trends for the coming twelve months.

Another meeting was held December 18, and was attended by approximately twenty-five members. Representatives of various industries made forecasts of general business conditions for 1931. It was striking to find a marked unity of opinion regarding the future. The analyst curve of business conditions was used as a base and projected into the next twelve months. The index for December, 1930, showed a deviation of −25. The ensuing months started an up-turn, gradual at first, but moving at an accelerating rate toward the close of the year. Even so, the entire curve was below normal with December, 1931, estimated as likely to record a minus deviation of 10 per cent.

Interest in the meetings has been well maintained and discussion emanating from respective men in key industries has been helpful to the group in its effort to acquire a good local, as well as national slant on business conditions.

The San Francisco Chapter.—The seventeenth dinner meeting of the San Francisco Chapter was held at the Bellevue Hotel, San Francisco, on October 31, 1930.

Incumbent officers—Oliver P. Wheeler, President; H. D. Gidney, Vice-President; and M. K. Bennett, Secretary-Treasurer—were elected to serve for the year 1930–1931.

Dr. M. K. Bennett of the Food Research Institute of Stanford University addressed the meeting on the subject, "Behavior of Wheat Prices in a Period of Economic Depression." Dr. Bennett was concerned chiefly to inquire whether wheat prices declined as they did between August, 1929, and July, 1930, largely because world-wide economic depression, with general decline of commodity prices, appeared in the period; or whether a reasonable explanation of the wheat price movement could be obtained by reference to factors in the wheat situation itself. No evidence appeared to show that economic depression significantly affected wheat consumption; its effect rather seemed to be to weaken the disposition to hold wheat stocks. Stocks, however, were so large when the year opened, and events during the year were such that the

disposition to hold might possibly have been awakened as it was even in the absence of economic depression. Hence it was possible to adopt the view that events in the world of wheat contributed to declining wholesale prices in general, in contradistinction to the view that the decline of wholesale prices was a credit and monetary phenomenon that had its repercussions on wheat. But a definite conclusion was impossible, largely because the interacting causes were so numerous and because no way appeared to evaluate quantitatively the several factors that seem to have affected the course of wheat prices.

Mr. A. M. Brown of the Balfour Guthrie Company, and Mr. H. P. Iverson of the Sperry Flour Company, discussed the paper. Other representatives of the grain trade in San Francisco attended the meeting.

Committee on Governmental Labor Statistics.—The Committee on Governmental Labor Statistics plans to devote most of its effort during the first half of the year to the completion of its report on Public Employment Office Statistics in Europe and America so that the findings may be submitted to the International Association of Public Employment Services at its annual meeting in September. It was at the request of the Association that the Committee began this study. The material available at Ottawa, Canada, is now being examined for the Canadian section of the report, and a questionnaire has been forwarded to all state employment services in the United States. The Committee is making every effort to press forward with this report, in view of a considerable demand for its findings for use in the revision of legislation governing public employment offices now being considered in a number of states.

The Committee's survey of wage statistics in the United States is progressing in the hands of a subcommittee, of which Mr. Roswell F. Phelps, of the Massachusetts Department of Labor and Industries, is chairman. It is hoped that the inquiry may be extended during the year, and Mr. Phelps intends to convene the subcommittee in New York early in the year to plan for the work.

It will be remembered that in coöperation with the Welfare Council of New York the Committee has been trying to interest the New York City government in the construction of a monthly employment and payroll record for the city's own employment. The Committee made a compilation of the numbers employed and the amount of the payroll for two months, but was unable to persuade the city to carry on the work. An effort by the federal government is now under way to secure statistics of this kind from a number of cities throughout the country, and it is hoped that this may prove more successful.

Bureau of Agricultural Economics.—The Bureau of Agricultural Economics of the United States Department of Agriculture is coöperating with Cornell University in collecting prices that farmers in New York have received for products that they have sold, and paid for what they have bought during the past century. From the data index numbers of prices will be constructed. The relation of agricultural production to prices will also be studied. Mr. Howard Stover of Cornell University has been employed to carry through this research project. A similar project is being organized in Wisconsin in coöperation with the University of Wisconsin.

The Bureau of Agricultural Economics is coöperating with the University of Maryland and the Baltimore Dairy Council in a survey of the consumption of dairy products in Baltimore. The purpose of the survey is to ascertain per capita consumption of milk and factors affecting the consumption. The effect of variations in income upon milk consumption is receiving special attention. The Bureau is also coöperating

with the New England Research Council in making a similar survey of milk consumption in Boston.

Mr. Clinton F. Wells, formerly employed as Market Analyst in the Federal-State Market Service, Sacramento, California, has recently joined the staff of the Division of Statistical and Historical Research, Bureau of Agricultural Economics, to do research in the relation of tariffs to agriculture.

Mr. Herman Stoker, a graduate student of Cornell University who has had a fellowship from the Brookings Institution during the past year for research in agricultural economics, is completing in the Division of Statistical and Historical Research, Bureau of Agricultural Economics, an analysis of world wool production and price statistics. The most definite contribution of this study will be the statistical separation of fine from medium wools, and a separate price analysis of these two classes of wools.

Land Utilization and the Farm Problem is the subject of U. S. Department of Agriculture Miscellaneous Publication No. 97, by L. C. Gray and O. E. Baker. This publication includes many charts illustrating significant changes in agriculture.

The following appointments to foreign posts have been made by the Division of Foreign Agricultural Service, Bureau of Agricultural Economics:

E. C. Paxton, Agricultural Commissioner, Sydney, Australia (formerly Agricultural Statistician in Kansas).

G. S. Ray, Agricultural Commissioner, Buenos Aires, Argentina (formerly Agricultural Statistician in Ohio).

C. C. Taylor, Agricultural Attaché, Pretoria, South Africa (formerly head of the Department of Agricultural Economics, Virginia Polytechnic Institute, Blacksburg, Virginia).

These men will report on crop and livestock production and conditions affecting production in their respective territories. Mr. O. L. Dawson, formerly Assistant Agricultural Commissioner at Berlin, has been appointed Agricultural Commissioner and is to be stationed at Shanghai, relieving Mr. P. O. Nyhus, who is returning to the States. Mr. Dawson will report on crop and livestock production and also the demand for our agricultural products in China.

A regional outlook conference on southern agriculture was held in Atlanta, November 11–14, 1930. Following this conference the Bureau of Agricultural Economics published Miscellaneous Publication No. 104, which deals with the outlook for 1931–1932, the long-time outlook for southern agriculture, and also contains a statistical statement relative to the world cotton situation.

The annual agricultural outlook conference was held by the Department of Agriculture in Washington, January 26–31, 1931, and the Agricultural Outlook Report was published February 2.

Four recently mimeographed reports of the Bureau are: *Domestic Demand in 1930 and Prospects for 1931*—Abstracts of Addresses by L. H. Bean; *Relation Between Production, Prices, and Acreage of Potatoes in North Carolina*—Abstracts of Addresses by L. H. Bean; *The Reduced Feed Supply and Its Relation to the Livestock Outlook*, by G. B. Thorne; and *The Effect of the Business Depression on Agriculture*, by O. C. Stine.

United States Bureau of Labor Statistics.—Field work on a survey of wages and hours of labor in the bituminous coal industry was started by the Bureau early in January.

The report on labor conditions in the Hawaiian Islands has been completed and is now in press, and bulletins on wages and hours in the following industries are being

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The report on labor conditions in the Hawaiian Islands has been completed and is now in press, and bulletins on wages and hours in the following industries are being

edited for the printer or are already in press: woolen and worsted, cotton, and rayon manufacturing; textile dyeing and finishing; and slaughtering and meat-packing. Tabulation of data on wages and hours is in progress for the lumber, men's clothing, sugar-refining, and hosiery and underwear industries. Summary figures for all of the above industries have been published in the *Labor Review*, with the exception of lumber, men's clothing, and sugar-refining, and data for the latter industries will be published as the tabulations are completed. Field work on a survey of wages and hours in the motor-vehicle industry has been finished.

The Bureau is continuing the expansion of its work on volume of employment. During recent months the main industrial groups for which monthly figures on trend of employment and pay rolls are published were augmented by laundries and dyeing and cleaning establishments; the other main groups are manufacturing, mining, quarrying, crude-petroleum production, public utilities, trade, hotels, and canning and preserving. Recent additions to the manufacturing group were beet sugar; beverages; and cash registers, adding machines, and calculating machines.

The results of the statistical study of coöperative associations, covering the period 1926 to 1929, are now in press. A series of articles on this study, giving summary data on various phases of the coöperative movement, has appeared in the *Labor Review*.

Women's Bureau of the United States Department of Labor.—The Women's Bureau has recently completed a survey of the fluctuations of employment in the radio industry in 1929 and such earlier years as could be studied from the employment records of manufacturing firms. The purpose of the study was to ascertain what foundation existed for the complaints received of undertime and lay-offs in plants making radio sets and tubes, whether or not it was a local condition affecting a few plants or typical of the industry as a whole, and whether or not it was a usual slump recurring from year to year. Employment data were obtained from 26 firms making receiving sets, from 15 making tubes, and from 10 making parts or accessories. These firms were located in nine states, in two of which much of the industry centers, and the data represent employment conditions in factories that made 80 to 90 per cent of the sets and at least 90 per cent of the tubes manufactured in 1929.

Plants manufacturing radio sets, radio tubes, and parts and accessories are treated separately. The manufacture of radio parts and accessories is not concentrated in a dozen or so outstanding firms as is the case in the manufacture of receiving sets and tubes, but is scattered throughout the East and West, and in a great majority of the firms a large part of the production is for use in other industries, so that it was impossible to make a distinction between the labor on radio parts and that on other products.

In the Bureau report the trends of employment are graphically presented in a series of charts; some are for individual plants while others are composite curves. The charts do not indicate a standard or mode of employment, but picture rather a series of abrupt hills and valleys illustrative of the very highly seasonal nature of the work during the past five years, the recurring depression year after year tending almost to obscure the general upward trend of employment in the industry during that period.

The composite curve of employment for the 10 representative plants making tubes is smoother than that for the 8 plants making receiving sets in the same four years. In the plants making receiving sets the minimum employment is from 30 to 41 per cent of the maximum in each of the four years, while in the plants making tubes the range is from 44 to 63 per cent. In other words, more than one-half of the men and

women employed during the peak period in tube factories were retained during the ensuing depression, but only from one-third to two-fifths of those in receiving-set factories were so fortunate.

Seven firms making radio sets had fairly complete employment data for 1929, and analysis of this reveals an appallingly high labor turnover. During the year, about 49,000 people were hired and rehired, in the seven plants reporting, and almost 51,000 were laid off, discharged, or quit. There were 1,850 more separations than accessions.

The most common hours in the plants were 8½ or 9 a day and 48 a week, rarely being more than 50 hours a week. Extra shifts and overtime were of brief duration and quickly succeeded by undertime, even for those employees retained at the end of the busy season. Wages varied from city to city and from plant to plant, the average weekly earnings ranging from $15 to $20 and the maximum earnings quoted usually being from $20 to $30.

Radio, like automobiles, is often referred to as one of the newer industries that are absorbing labor laid off by the slack in other lines. But if such industries, in turn, are to make very irregular and intermittent demands for employees, the result will be a greatly enlarged supply of shifting labor, moving about as one industry after another offers a few weeks' work.

To meet a growing demand for informative material as to the nature of the work of the Women's Bureau, a collection of articles on the activities and findings of the Bureau is being published in bulletin form under the title "Fact Finding with the Women's Bureau." The bulletin sets forth the purpose and methods of the Bureau's investigations and presents in summary form the industrial standards upheld by the Bureau and the results of its studies to date.

Advisory Committee on Employment Statistics.—This Committee was appointed by President Hoover in July and included the following members: Ethelbert Stewart, W. N. Stewart, John P. Frey, P. W. Litchfield, Harold F. Brown, Secretary Doak (ex-officio), Secretary Lamont (ex-officio), Leo Wolman, Noel Sargeant, Arthur Wharton, Joseph H. Willits (Chairman).

The Committee was appointed to study means of measuring employment and unemployment. A Sub-Committee on Employment Statistics was appointed for this purpose including the following: Leo Wolman (Chairman), Harold F. Brown, Noel Sargeant, Arthur Wharton. Technical Advisors: Otto Beyer, International Association of Machinists; Bryce M. Stewart, Industrial Relations Counselors; Matthew Woll, Vice-President, American Federation of Labor; W. C. Berridge, Metropolitan Life Insurance Company; Ralph Hurlin, Russell Sage Foundation; Thomas S. Holden, F. W. Dodge Corporation; Meredith B. Givens, Social Science Research Council; E. F. Hartley, Manager, Business Service Department, International Business Machine Corporation.

At the time the Committee was first called together on October 22 it was asked also to consider questions of technological unemployment; specifically it was asked to indicate whether it thought a comprehensive study of the problem should be made and if so the lines along which to proceed.

A Sub-Committee on Technological Unemployment was appointed consisting of the following: J. H. Willits (Chairman), P. W. Litchfield, John P. Frey, Leo Wolman. Technical Advisors: Benjamin Squires, Impartial Chairman, Men's Clothing Industry; H. S. Person, Managing Director, Taylor Society; J. M. Clark, Columbia University; Sumner Slichter, Harvard University; William Green, President, Ameri-

can Federation of Labor; Ewan Clague, Yale University; Anne Bezanson, University of Pennsylvania.

Both of these sub-committees have been at work and it is expected they will report soon.

The Rudolf Funke Prize.—In accordance with Article 6 of the *Rudolf Funke Foundation* the Institut für Weltwirtschaft und Seeverkehr at the University of Kiel will award a prize for a thesis on the subject: The International Inter-Relationship of Economic Fluctuations.

The thesis should trace the development of economic fluctuations with typical examples from the beginning of the nineteenth century to the present day with a view to ascertaining whether the economic fluctuations of various countries coincide, or not, in time, intensity and otherwise—and if so, to what extent. In this connection, not only the various periods in the development of capitalism, but also the relations existing between different branches of economic life (e.g. manufactures, raw materials, agriculture) are to be taken into consideration. An historical-theoretical analysis of demonstrable unilateral or mutual influences is to be combined with this empirical description. At the same time the author is to show the different typical forms in which these fluctuations spread over the world. He is to explain the part played by psychical and material factors during this process (e.g. speculation, technical inventions, migrations, foreign trade, movements of capital). The general problems of the theory of economic fluctuations are not to be placed in the foreground; the author, however, should examine to what extent his own particular theory of the international inter-relationship of economic fluctuations agrees with the general theory of economic fluctuations.

This prize is open for competition to any individual research worker, or to any group of research workers, or to any Institute.

The winner will be awarded the Rudolf Funke Prize of RM. 18000 and the Rudolf Funke Gold Medal. The Institute herewith reserves the right to purchase any thesis submitted for competition, even though it does not win the prize.

The thesis shall be typewritten (5 copies) in German or in English and must be handed in to the Secretary of the Institut für Weltwirtschaft und Seeverkehr at the University of Kiel not later than December 31, 1932. It shall be signed with a pen name; this pen name shall also be upon an envelope bearing the name and address of the author which will be submitted with the thesis. In the case of a group of authors, the names of all the contributors must be mentioned.

The following have consented to act as judges:

Professor Dr. A. Aftalion, University of Paris
Professor Dr. L. Birck, University of Copenhagen
Professor Dr. B. Harms, University of Kiel
Professor Dr. E. Lederer, University of Heidelberg
Professor Dr. Wesley C. Mitchell, Columbia University
Mr. D. H. Robertson, M. A., University of Cambridge
Professor Dr. J. Schumpeter, University of Bonn
President Professor Dr. E. Wagemann, University of Berlin and Deutsches Institut für Konjunkturforschung.

Police Statistics.—Extensive current monthly collection of police statistics in the United States, inaugurated at the beginning of 1930 by the International Association of Chiefs of Police, has been transferred to the recently created Division of Identification and Information of the United States Department of Justice.

Henry Rogers Seager: 1870–1930

The tragic death of Henry R. Seager at Kiev last August deprived the social sciences of one of their wisest leaders—one from whom much was expected in the decade to come. Although he had reached the age of sixty, Professor Seager was just beginning a new series of studies with the zest of youth. In July he led a small party of economists to Russia to make a preliminary reconnaissance of the momentous experiment in communism. No one has attacked that passion-clouded problem with a fairer mind, or a sounder judgment. Seager thought of his summer visit as merely laying the basis for intensive work which he expected to continue for several years. In our efforts to weigh the merits and defects of the Russian scheme, we sorely needed the guidance of his clear and steady mind. But he overtaxed his strength by strenuous exertions under hard conditions and fell a victim to pneumonia.

Born in Lansing, July 21, 1870, Seager entered the University of Michigan at a time when the social disciplines were shifting from a philosophic to a scientific basis in this country. Among his classmates were James R. Angell and Edwin F. Gay. After receiving his bachelor's degree in the spring of 1890, he went in the autumn to work with Herbert B. Adams and Richard T. Ely at Johns Hopkins. Next year, he joined the long procession of young economists which John Bates Clark had led in 1873 toward the universities of Germany. Seager spent two years in Halle, Berlin and Vienna, gaining a close acquaintance with both the historical and the Austrian schools of economic thought, then so sharply opposed to each other. Returning to the United States, he spent another year of post-graduate study with Simon N. Patten at the University of Pennsylvania, and received his doctor's degree in 1894.

It was thus with a well-rounded technical training that young Dr. Seager began his teaching career in the autumn of 1894 as an instructor in the Wharton School. Personal qualities of a high order contributed to his prompt and lasting success. Seager had admirable powers of exposition, a delightful vein of humor, a kindliness that embraced all sorts and conditions of men, and a keen interest in the personal fortunes of his students. He was made an assistant professor in 1896, called to Columbia as adjunct professor in 1902, and promoted to a full professorship in 1905. No economist of his time is held in more affectionate esteem by the successive generations of young men and women who sat in his classrooms and did 'prentice work under his guidance.

With his teaching, Professor Seager combined an eager interest in social problems and an active share in social movements. He was one of the founders of the American Association for Labor Legislation and served as its president for three years. In 1909 the Governor of New York appointed him vice-chairman of the Wainwright Commission to study employers' liability. The American laws concerning workmen's compensation for industrial accidents were molded in large part by the work of this Commission, in which Seager took a leader's share. His constructive ideas on the problem were presented in the Kennedy Lectures which he delivered at the New York School for Social Work in 1909 and published in 1910 under the title, *Social Insurance: A Program of Social Reform*. Seager was also an active supporter of *Charities and the Commons*, now *The Survey*, of Greenwich House, one of the foremost American "settlements," and of the Academy of Political Science. In 1917–19 he served as Secretary of the Shipbuilding Labor Adjustment Board. In collaboration with Willard E. Hotchkiss, he gave an account of this experience in bulletin No. 283 of the United States Bureau of Labor Statistics, *History of the Shipbuilding Labor Adjustment Board*. After the War he acted as executive-secretary of the President's Second

Industrial Conference in 1919–20. This is a most inadequate note upon his social services; for his wise counsel was continually put under contribution by the sponsors for a wide range of social movements.

Freely as he gave himself to teaching and to social service, Professor Seager remained a scientific inquirer, forming his opinions on the basis of wide-ranging factual studies and sober analysis. Besides a series of technical papers in such journals as the *Political Science Quarterly* and the *American Economic Review*, he published an *Introduction to Economics* in 1904, a more elaborate *Principles of Economics* in 1913, and *Trust and Corporation Problems* in 1929. His books had a wide circulation, and passed through several editions; for besides the lucidity and admirable balance which were so characteristic of their author, the volumes exhibit economics as dealing with the actual world in which we have to coöperate and compete with our fellows under constantly changing conditions. Seager was a thorough realist, always ready to face the facts however complicated or discouraging, but equally intent upon clear thinking. His professional standing was recognized by his election in 1922 as president of the American Economic Association. A full bibliography of his writings will soon appear in the volume commemorating the 25th anniversary of the Columbia Faculty of Political Science. One of his students and co-workers hopes to publish a memorial collection of his occasional papers.

Through all Henry Seager's work as teacher, socially-minded citizen and economist, shone the qualities of a grand human being. Generous and honest, eager and wise, he won the admiration and the love of all who came close to him.

Wesley C. Mitchell

Columbia University

Personal Notes

Professor Horace Secrist of Northwestern University School of Commerce is shortly to undertake an extended trip in the United States and abroad to confer with those in the economic and statistical fields regarding the tendency for a static condition to assert itself in the expenses and profits of business enterprises in the fields of banking, department store, clothing and hardware retail trade, and in the field of wholesale groceries.

Bryce M. Stewart, Director of Research of the Industrial Relations Counselors, and Executive Secretary of the Committee on Governmental Labor Statistics of this Association, is serving on the staff of the President's Emergency Committee for Employment, in charge of statistics.

Dr. M. J. B. Ezekiel, Assistant Chief Economist of the Federal Farm Board, is on leave of absence, and is spending the year in Europe as the holder of a Guggenheim Memorial Fellowship. He expects to return in September, 1931.

Dr. Garfield V. Cox, until recently Professor of Business Economics in the School of Commerce and Administration at the University of Chicago, has been transferred to a professorship in finance in the same institution.

Emery M. Foster, for several years Principal Statistical Assistant to the Chief of the Division of Statistics of the United States Office of Education, has recently been promoted to Chief of the Division succeeding Frank M. Phillips, who is now asso-

ciated with the United States Employees Compensation Commission, as actuary and statistician.

Dr. Morris Steggerda of the Carnegie Institution of Washington departed January 15 for Yucatan, where he is to make statistical studies on the physical and mental traits of Maya Indians and hybrids between them and whites.

MEMBERS ADDED SINCE DECEMBER, 1930

Adams, Lawrence A., General American Investors Company, 120 Broadway, New York City

Bacon, Dr. Dorothy C., Research Associate, National Bureau of Economic Research, 51 Madison Avenue, New York City

Balog, J. F., Royal Insurance Company, Ltd., 150 William Street, New York City

Benz, Luke L., Buying and Underwriting Department, Blythe and Company, 120 Broadway, New York City

Billard, Gordon Y., Senior Statistician, Ludwig Robertson and Company, 11 Broadway, New York City

Black, Professor Loren T., Ashland College, Ashland, Ohio

Borum, Cecil J., Agricultural Statistician, Division of Crop and Livestock Estimates, U. S. Department of Agriculture, College Station, Brookings, S. Dak.

Brewer, Giles, Financial Comptroller and Secretary, Post Office Box 368, San Juan, Puerto Rico

Burnett, Marguerite, Reference Library, Federal Reserve Bank of New York, 33 Liberty Street, New York City

Cahen, Alfred, Jr., Student, 1325 John Jay Hall, Columbia University, New York City

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REVIEWS

Synthetic Economics, by Henry L. Moore. New York: The Macmillan Company. 1929. 186 pp.

The concept of equilibrium has tended to become increasingly the unifying idea of theoretical economics. The materialization of the concept has been the construction of a hypothetical economy in which there is no incentive for readjustment. The conditions of equilibrium for a single commodity were first investigated rigorously by Cournot, the founder of mathematical economics. Some years later, the conditions of a general economic equilibrium, that is, equilibrium in the system of economic quantities, were explicated by Walras and his disciples—the *École de Lausanne*. The theoretical systems of economic equilibrium have hitherto rested on the postulates of economic rationality and free competition, and have been confined to the theoretician's static economy.

Umberto Ricci, whom Professor Moore quotes, has characterized the Walrasian construction as giving the "effect of an enchanted palace which delights the fantasy but does not help solve problems of housing." It is to a removal of the "sources of unreality" in the Walrasian system that *Synthetic Economics* aspires. The purpose is challenging in itself, for the opinion is general, even among exponents of the mathematical school, that the empirical derivation of the equations in the Walrasian system is practically an unattainable goal.

The term "synthetic economics," in Professor Moore's usage, includes the Walrasian system of static economic equilibrium, the extension of this system of equations to the dynamic economy, and the derivation of the empirical functions descriptive of the economy. But the statistical derivation of the parameters of the general functions of the economy is a task that Professor Moore neither does, nor very well could, undertake. All that he does along that line is to exemplify how the moving equilibrium of a particular commodity (potatoes) may be expressed numerically; the ultimate goal of "synthetic economics" is, therefore, not attained. He rather limits himself to the task of refashioning the Walrasian schema so as to make possible the statistical derivation of the equations of the system.

The reconstruction of Walras' system rests on a new concept of economic equilibrium, and on certain technical expedients which will be noted at a later point. Professor Moore posits the concept of a moving general equilibrium which is to apply to the perpetual flux of the actual economy. This equilibrium may be either "final" or "tentative." The final moving equilibrium is taken to be traced by the trends of the system of economic quantities. It is now, therefore, possible by expressing the variables in trend-ratio form to introduce the factor of change into the Walrasian system of equations. The economic system is in final moving equilibrium when there is a general coexistence of trend values: this means that the equilibrium values which will satisfy the system of equations may be known without solving the equations simultaneously. As for the tentative

economic equilibria, these are traced out by the oscillations about the system of economic trends. The representation of the equations in the system, by employing trend-ratios, reveals the sensitive spots of the economy where perturbations arise and thus makes possible a general theory of economic oscillations. Such are some of the ramifications of the new concept of equilibrium.

The other technical expedients whereby the Walrasian system is refashioned center about the uses to which the old concepts of elasticity of demand and supply, and the new concept of "relative efficiency of organization" are put. The Cournot-Marshall concept of elasticity of demand is extended to the case where demand is a function of the prices of all commodities. The broadened concept is called "partial elasticity of demand," which means the ratio of the relative change in the quantity demanded of, say, commodity C to the relative change in price per unit of, say, commodity F, when the demand for C is a function of the ensemble of prices. By making simple assumptions with respect to the character of partial elasticity of demand, such as, that it is a constant, or a linear or quadratic function of price, and then integrating, typical demand equations are deduced, and finally expressed in trend-ratio form. In an exactly similar way, now working with the concept of "partial elasticity of supply," typical supply functions admitting of numeric applications are set up.

In the system of equations representing a moving general equilibrium, coefficients of production are coördinate with functions of demand and supply. Coefficients of production are the quantities of the services of the factors of production that enter into the fashioning of a unit of the various commodities. In order to derive these coefficients, production functions must first be set up. It is in the elaboration of the production functions that the concept of a coefficient of "relative efficiency of organization" appears. This is defined as the "ratio of the relative change in total production to the relative change in total cost." The present coefficient plays a rôle in the production functions exactly analogous to that which the coefficient of elasticity of demand plays in the demand functions, and the coefficient of elasticity of supply in the supply functions. Thus, partial relative efficiencies of organization are first defined. Then, by making simple assumptions with respect to the form of the partial efficiencies, and integrating, typical production functions are deduced, which in a final step are written in trend-ratio form. In the resultant production functions, the partial relative efficiencies of organization are constants, and therefore may be concretely evaluated. Since the partial efficiencies are one of the factors of which the coefficients of production are quotients, it remains only to evaluate the second factor. The second factor is given by the partial derivatives of the quantities of production with respect to the quantities of the services of the factors of production that are used. By invoking the productivity theory of distribution, Professor Moore is able to assign certain trend prices as the values of the partial derivatives. In this way, then, coefficients of production are deduced.

Equipped now with "dynamic" demand and supply functions, and coefficients of production, Professor Moore possesses "the means by which to pass from Walras' hypothetical, statical general equilibrium to a real, moving general equilibrium." The conditions of a general equilibrium conceived by Walras are

most simply described by four groups of equations: $(m-1)$ equations of demand for the m commodities demanded, one commodity being taken as the standard of value (*numéraire*); n equations of supply of the n productive services; n equations showing equality between amounts of services demanded and quantities of services supplied; and m equations expressing the equality of costs and prices of commodities. It is in the latter two sets of equations that the coefficients of production enter. In all, there are $(2m+2n-1)$ independent equations which are sufficient to solve the $(2m+2n-1)$ unknowns: m quantities of commodities demanded, their $(m-1)$ prices, n quantities of services, and their n prices. It is this set of hypothetical equations that Professor Moore replaces with his concrete functions, and thereby achieves a "first approximation" to a moving equilibrium "about the lines of general trend."

By introducing "conditions of capitalization"—that is, the creation of new capital goods and their pricing, savings and credit, and the determination of the interest rate—a "second approximation" to a moving general equilibrium is effected. This involves the introduction of four additional groups of equations and a modification of three of the four groups of equations in the first approximation. But by taking the additional circumstances into account, the mathematical description is brought into "a more complete accord with economic facts." The result is a moving general equilibrium which reveals "the actual joint determination of the essential facts and laws of exchange, production, capitalization, and distribution."

In traditional theory, an economic equilibrium is essentially self-restorative—that is, a disturbance of the equilibrium sets forces in operation which tend to restore the equilibrium elements to their original position. This is a static concept taken over bodily into economic theory from mechanics. It has already been stated that Professor Moore's idea of equilibrium differs from the traditional concept, and that his equilibrium concept dominates his system: his conception of economic equilibrium is that of a moving, not a fixed, position. But at this point the difference between Professor Moore's and the traditional concepts of equilibrium ceases. As in the classical or mathematical systems (final) equilibrium is never actually reached, for there is never a general coexistence of trend values. As in these earlier systems again, the equilibrium is self-restorative: the economic system strives, "under the influence of relatively static forces, towards a moving general equilibrium." That the economic system is never actually in equilibrium means simply that "oscillations"—the term "economic rhythm" is once used—take place. The theory of moving equilibrium is therefore a stepping stone to the theory of economic oscillations.

An economic oscillation is defined as a "complete fluctuation of an economic quantity about its normal position of equilibrium." The phrase "economic cycles," which forms part of the titles of Professor Moore's two well-known works on periodic fluctuations, does not appear in *Synthetic Economics*; nor, for that matter, are these treatises even mentioned. But it is clear from the argument that the term "oscillations" covers both periodic and non-periodic fluctuations. By oscillations is therefore meant pretty much what "business cycles" are currently understood to mean. This point is worth stressing, for Professor Moore

departs sharply in *Synthetic Economics* from the theory of oscillations that is sketched in two articles on that subject that he published in the *Quarterly Journal of Economics* during 1926. In these articles, periodic and non-periodic oscillations were traced to separate causes, the former being assigned to variations in rainfall and crop yields, as expounded in *Generating Economic Cycles*, and the latter to perturbations of the moving general equilibrium. In the present treatise, there is a unification of the theories of periodic and non-periodic oscillations that is so complete that periodic oscillations are not even distinguished from non-periodic. By linking the whole theory of oscillations to the theory of moving equilibrium, an integration between the theory of business fluctuations and the general theory of value and distribution is effected. A system of economics of beautiful generality, suggestive of developments in modern physics, is thereby created.

Just as Professor Moore's theory of moving equilibrium has its roots in the Walras system, so his theory of oscillations takes Walras' analysis as a point of departure. Walras had shown that the perturbations of a static equilibrium are diffused throughout the economy in a set of oscillations which diminish progressively in amplitude. Similarly, Professor Moore views oscillations as deviations from equilibrium values which set up perturbations that tend to be diffused throughout the economy. These perturbations have their origin in certain "sensitive spots" of the economy. "Perturbations in certain spots are cumulative in effects, and in others are non-cumulative; . . . in certain spots perturbations are recurrent, while in others they are non-recurrent."

The sensitive spots of the economy where perturbations arise are held to be revealed "in fidelity and completeness" by the system of equations describing a moving general equilibrium. Thus, the demand and supply functions express trend-ratios of demand and supply, respectively, as dependent variables, and the trend-ratios of the system of prices as independent variables. Clearly, a perturbation in the standard of value will be cumulative in its effects, as it will affect all prices. Money, therefore, is one critical spot in the economy. The prices of the various consumer's goods are additional sensitive spots. But a perturbation in the price of a given consumer's good will not be cumulative in its effect, because it will not affect the system of prices in the same direction. The prices of the services of the factors of production contain another group of sensitive spots. Thus, if it be supposed that the price of the service of land per unit of commodity produced varies with changes in the weather, then, perturbations in this price will be cumulative and recurrent: they will be cumulative because the given price item enters into all food products and many raw materials, and recurrent because fluctuations in the weather are recurrent. Here, it may be noted parenthetically, is the link between Professor Moore's theory of "generating economic cycles" and the present "synthetic theory of economic oscillations." A further examination of the system of equations reveals additional sensitive spots of the economy in which perturbations have their source. The systematic disclosure of the sensitive spots of the economy which the equational system makes possible reveals incidentally the "partial truth in the leading contemporary theories of trade oscillations." The sum of the partial truths in the way of an

"eclectic recognition of the grain of truth in all things erroneous," does not yield the whole truth. For a "synthetic view of all sources of oscillation," one must turn to the theory of moving equilibrium.

Such are the major outlines of Professor Moore's theoretical structure. But what is its conceptual foundation? The premise of "free competition," which is basic in Walras' system, cannot serve this purpose, for that premise, being inconsistent with experience, can only lead to a hypothetical theory, and Professor Moore's theory has economic realities as its sphere. But the premise of "competition" in its "original and real sense" that every member of economic society seeks to maximize his income will serve well enough. This, then, is set up as the "fundamental premise" of economic science. Though the matter is left at this point, and no attempt is made to connect up intimately the functioning of the economy with what is put forward as its psychological foundation, the premise in question—which is no more than the familiar "economic principle"—suffuses the whole work. It is this principle that endows with meaning the algebraic demand and supply functions, the statistical expression of laws of supply which relate given year production-trend-ratios with preceding year price-trend-ratios, the notion of partial efficiency of organization, and the remaining parts of the system.

In turning to an appraisal of Professor Moore's *Synthetic Economics*, the best criterion to employ is one that he himself incidentally put forward in contrasting the "synthetic" and "mathematical" methods. "Synthetic theory," Professor Moore writes, "has practice as its goal." What is "an impertinence from the point of view of pure, mathematical theory" may be a "critical question from the point of view of practice." The mathematical economist "is concerned with theorems, not with practice. . . . The object changes when we pass from pure theory to practice: Utility becomes the goal, and logical consistency is valued in the degree in which it is useful." Clearly, Professor Moore's purpose is to provide a theory that will interpret the complexities of the actual economy. A scientific work is to be adjudged in the light of its purpose. How adequate, then, is *Synthetic Economics*, as a theory of "economic dynamics," or as a framework for such a theory?

Professor Moore nowhere states explicitly that his synthetic theory of the economy is to be taken as a general program for a comprehensive statistical research. Yet the whole spirit of his treatise suggests this to be its fundamental purpose. It seems clear from some of the quotations that have been made, and even clearer from a full reading of the book, that Professor Moore has labored to express the general functions of the economy in a form admitting of statistical statement, primarily with the hope that such statistical statements will be actually forthcoming. This being so, the points might be raised at once that a complete, or even a moderately comprehensive, evaluation of the constants in Professor Moore's system of equations would call for a vastly completer statistical record of economic experience than is presently had or is likely to be had in the significant reckonable future, and further, that the statistical work required would be extraordinarily, almost superhumanly, laborious. To strengthen these observations, it is only necessary to point out that the minimum period (years) over which

the observations would have to run is fixed by the number of independent variables in any of the demand, supply, or production functions. Such criticism, however, is captious and unenlightening. It is fairer and more fruitful to view Professor Moore's equational system as a goal that can be approached in this day in some slight degree, and in the future in somewhat greater degree.

To gain insight into Professor Moore's theory, let the practical difficulties of paucity of statistical data and laboriousness of enterprise be set aside. Let the problem be the determination of the law of demand of, say, potatoes by one of Professor Moore's simpler methods, the demand for potatoes being taken as a function of the prices of, say, thirty commodities. The independent variables that are to be chosen for the assumed problem are those that are most "significant." But one serious limitation surrounds the choice of these variables: no good that has ceased to be produced during this interval, or that has been introduced during this interval, can possibly be included: the choice of data is limited to that part of the production-price area that is common to each year of the period to which the observations refer. This difficulty is crucial; for in a rapidly shifting economy such as ours, where new products are incessantly introduced and old products fall into desuetude, it is very unlikely that a fixed list of prices will bear the most significant relation to the demand for potatoes in each year of a considerable period. And if this is true of potatoes, a staple, it is much more true of bicycles and buggies, and the host of style goods. Confined implicitly to an economy of a fixed production-price pattern, Professor Moore's theory does not take full cognizance of the dynamics of the actual economy. The theory would hold inexorably only for an economy in which the number and kind of commodities were fixed, but in which there was any sort of fluctuation in prices, volume of production, and coefficients of production.

The above hypothetical example reveals incidentally another limitation of Professor Moore's system as a theory of economic dynamics. In the derivation of the demand functions—and similarly with the other functions in the equational system—statistical time series are employed. But these series are reduced, in the process of connecting trend-ratios in a single equation, to a temporal form. The resultant functions are, therefore, average functions: in the above hypothetical case, the law of demand would hold for the interval as a whole. If by dynamic theory is meant a generalized description and explanation of the process of cumulative change, the functions in Professor Moore's system, though "empirical," are hardly "dynamic."

Difficulties multiply as the criterion of dynamics is further applied to Professor Moore's system. *Synthetic Economics* takes the secular trends of the economy as its pivot, but it does not provide a really satisfactory theory of these trends. In the introductory chapter to the treatise, we read that synthetic economics "is intended to indicate a concrete, positive description of moving equilibria, oscillations, and secular change, by a method which presents all of the interrelated economic quantities in a synthesis of simultaneous, real equations." But in the substantive parts of the treatise, descriptions of "secular change" are used only for arriving at the trend-ratios of the variables of the system. The lack of insistence on secular trends as objects of curiosity in their own right may be explained

by Professor Moore's preoccupation with the theories of moving equilibrium and oscillations. Even then, *Synthetic Economics* provides only for a description and not at all for an explanation of secular trends.

Synthetic Economics does, however, contain implicitly an interpretation of secular trends as a generic economic phenomenon. The economic system is conceived as striving towards an equilibrium which is traced out by the trends of the economy. Trend values are assumed to be "the values toward which the forces at work are urging the movement" of economic quantities. On this view, secular trends are telic economic realities rather than convenient *post facto* descriptions of historico-economic movements. This is a basic idea underlying Professor Moore's system. The idea is useful in enabling Professor Moore to pass from Walras' static equilibrium to a moving equilibrium. But the interpretation of secular trends that it carries with it will not be very helpful to the economist who is interested in explaining the trends of real economic phenomena.

When secular trends are treated as shifting goals of economic phenomena and no more, the major portion of economic change is taken for granted and really left out of account. The dynamic economic forces—changes in population, the industrial arts, business organization, capital accumulation, and demand—have their most important impact on the secular component of economic quantities. The causes of a variable rate of industrial growth, the influence of divergence in production trends on the severity of business depressions, the causes of a general tendency towards a retardation of industrial growth, the incidence of secular changes in prices on production trends and cycles in general business—these are a few of the problems concerning economic reality that a theory of economic dynamics must needs embrace, if only schematically. And when such problems of secular change are tackled, the very conception of trends that Professor Moore offers is inadequate. In order that the trends be established statistically, a more precise concept than that of an equilibrium path is necessary.

In the light of the criterion of dynamics, the theory of oscillations is more satisfactory than any other part of Professor Moore's system. The equations defining the general moving equilibrium do reveal the sensitive spots of the economy where oscillations have their origins. But it is worth indicating the exact import of this theory. Professor Moore does not make the point, but it seems obvious that only the perturbations that are cumulative and recurrent can engender general economic oscillations—although a recent theory traces oscillations to the cumulation of random changes. What perturbations are cumulative and recurrent is something that cannot be learned *from* the system of equations. It is rather something that must be brought *to* the system of equations. Professor Moore's theory of oscillations is to be viewed, then, as an intellectual apparatus for unifying certain portions of analytical, statistical, and historical research on business fluctuations. It may be observed that Professor Mitchell's concept of "the equilibrium of a balance sheet" serves a somewhat similar purpose.

The present evaluation of his theory of oscillations is one that Professor Moore would almost certainly reject. He makes substantially greater claims for the theory: the system of equations not only reveals the sensitive spots of the econ-

omy, but also affords a technique "for appraising the relative importance of perturbations in the various sensitive spots of the industrial organism." "The complete theory of oscillations . . . would be approached by successive approximations. A first approximation would take cognizance of the most important cause of perturbation, and the successive approximations would be made by combining the effects of the several perturbing causes." The hope is expressed that the employment of the synthetic method may "introduce into economic life rational forecasting and enlightened control." It is clear enough that a knowledge of causes is a prerequisite to rational forecasting and that the functional treatment of economic elements is indispensable to correct causal allocation. Yet, if *Synthetic Economics* is not completely satisfactory as a theory of economic dynamics, it is also defective as an organon for economic prognosis. The equations in Professor Moore's system can never do more than enable us to say what is likely to happen in one economic sphere, when a specified change takes place in certain other spheres; but changes in the economy are numberless, synchronous, and incessant. One reason why economic forecasting can never have the quality of perfection of the Nautical Almanac, is that the number of variables in the economic system is itself a variable. Then again, "rational forecasting," though a necessary condition for "enlightened control," may not be a sufficient condition. If, for example, economic oscillations are finally traceable to variations in crop yields, it is difficult to see how oscillations may be controlled, at least in an economic régime based on the institution of private property.

Since Professor Moore has averred that the canon of "logical consistency" is subordinate to "utility" in *Synthetic Economics*, it would be an impertinence to point out a logical flaw in the system, were it not for the bearing on its satisfactoriness as a theory of economic dynamics. Much is made of the unreality of the promise of "free competition" in the Walras system. This premise is renounced, termed a "spurious superfoetation," and the "economic principle" is put forward as the major premise of synthetic economics. But as a matter of fact, the premise of free competition plays a rôle coördinate with the premise of economic rationality in the actual working out of the synthetic theory. The premise of free competition, though explicitly rejected, is implicitly introduced in the equilibrium equations showing that cost equals price, and that the total product of industry is the sum of the marginal products of the factors of production multiplied by the appropriate number of units of each factor. To be sure, Professor Moore's theory of departures from equilibrium does not rest on the premise of free competition; but neither, for that matter, does the theory of Walras or Pareto.

In appraising *Synthetic Economics* from the standpoint of its adequacy as a theory of economic dynamics, attention has centered on those limitations of Professor Moore's theory which seem inherent in it. If the limitations that have been adduced are really intrinsic, the root of the difficulty would seem to lie in the Walrasian starting-point of Professor Moore's system rather than in his own elaboration. There is a second class of objections to Professor Moore's theory, but these are unimportant, since they admit of correction. Thus no account is taken in the system of equations of conditions of foreign trade, variations in

commodity stocks, the pricing of corporate shares, taxation, and numerous other important features of the real economy. Yet it must be remembered that only a "first" and "second" approximation to a theory of moving equilibrium are offered. With *Synthetic Economics* written, it should not be difficult to include in the mathematical system many of the omitted features of actual economic life.

Synthetic Economics is not fully adequate as a theory of economic dynamics, but it is a boldly inspired, systematic attempt at such a theory. It is the crowning work of one of the most brilliant of living economists, who has wrestled heroically with the problem of providing a "statistical complement to pure economics." The book has the dimensions of a classic, and will undoubtedly take its place among the masterpieces of economic literature. It will also have the beneficial effect of leading to further refinements in the mathematical theory of economics and to more ambitious work in the field of price analysis. But whether a systematic theory of economic dynamics is pragmatically valuable at the present time except in the way of a number of guiding notions, and whether the most fruitful approach is had in Professor Moore's system, are questions that the future will answer.

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The Assignats, by S. E. Harris. Cambridge, Massachusetts: Harvard Economic Series, Harvard University Press, 1930. xix, 293 pp.

Contemporary thinking is concentrated to an extraordinary degree on monetary theory. For this reason *The Assignats* by Seymour Harris is of great interest at this time, and should form as well a permanent foundation stone in the building of a sound structure for economic life. The book is of such high calibre that it would be unwise to stress some of the deficiencies of style and arrangement. These do not interfere with the reasoning or with an appraisal of the conclusions.

The first point which strikes the reader is that the Assignat experience was much more like modern incidents of depreciation than has been generally supposed. The efforts to maintain the value of the currency were very much like those in France, Germany, Austria, and many other countries after 1918. Moreover, the thinking was not limited to crude fallacies but was surprisingly similar to the more refined theories of money. Those who consider that some kind of inflation could solve the present economic crisis should not dismiss this earlier experience too lightly.

The second fact which emerges is the influence of land as a security behind the money. Harris concludes that it was partly successful (pp. xvi, 90) and points to the case of the *rentenmark* in Germany when land was used to support the new money which pulled Germany out of the swamp of depreciation. The very nature of the monetary standard is thrown into sharp relief by these two cases. Many commodities have served as standards of value; to the extent that they help to delimit the area within which values fluctuate, they are *good* standards. Their functions depend in part on the public attitude. Land can,

apparently, serve for short periods, and on the contrary, it is possible that gold might become less good. The present public preoccupation with gold production, for instance, might so destroy economic habits of thought that gold would be slightly impaired as a monetary standard.

The third general conclusion, stressed in connection with the part which land played, was that confidence was an important causal factor in determining the value of the Assignats. This was indicated in a number of connections (pp. 90, 164, 238, 262, and others). Unfortunately, it is not brought out emphatically in the summary of causes (pp. 201–205); perhaps, in part because this concept has not yet been thoroughly fitted into the pattern of economic thought. It suffers from the lack of concrete, exact terminology.

Velocity of circulation, an aspect of speculation and of confidence, is given as a partial explanation of degrees of depreciation. Harris could go further, and make velocity a generalized explanation of most of the internal variations in prices. He is puzzled by the discrepancies in adjacent territories, but these were in all probability caused by differences in velocity in an almost literal sense of the word. Regions which were close neighbors on the map were, and are, in many cases widely separated by differences in custom, in the development of trade facilities, and in standard of living. This is particularly true of the *Vendée* which Harris mentions a number of times as inexplicable on the basis of the statistical evidence alone. Even during the recent depreciation there were surprising discrepancies between the different departments which offer striking evidence of the different ways in which people value and use money.

Despite these differences in local value, Harris favors the use of prices as the main measure of depreciation. His emphasis on the results of different measures is very valuable and is a needed refinement lacking in some of the earlier discussions. It is not entirely clear, however, that he has made a strong enough case for the subordination of foreign exchange rates. The choice of a measure depends essentially on the purpose of the analysis. This being so, it seems wise to give the foreign exchanges equal importance alongside of prices. The exchange rates are a simpler, more easily computed, and easily checked measure, whereas prices vary in significance with changes in budgets, in qualities of goods, in computation of index numbers, and in localities. Both are influenced by production and commerce, but this should not disqualify either (pp. 97–102). The comments on the relation of the gold points to exchange rates are certainly open to criticism (p. 93, 259). Depreciation is almost always a "movement of the gold points" and the exchange rates were not less "accurate" because "the gold points were unstable" (p. 93).

Attempts were made in the time of the Assignats to lessen the injustice of the effects of depreciation on creditor-debtor relations by the construction of tables, by revalorization laws and other measures (p. 217). As usual, the results were futile. The discussion of these efforts might have been strengthened if Harris had used modern terminology in reinterpreting the older discussion, and had included some of the other aspects of the *accounting function* of money. The efforts of France to get back to a partially metallic currency, were not easy, according to Harris. He even generalizes—"The required adjustments do not

occur automatically as some would have us believe" (p. 219). His investigations put him in an authoritative position to make this statement, but the facts which he presents to the reader do not prove his case, particularly in view of the surprising ease in France in 1926, and Germany in 1924.

The book is exceedingly important to all interested in the analysis of monetary principles. It includes a well-documented political and economic discussion and detailed accounts of price control, subsistence markets, monetary laws and similar data as well as a judicious use of available statistics. Its thoroughness of research and quality of analysis are above reproach. Thus it fully justifies the aims which the author outlines in the preface, and should be an indispensable addition to any library of the student of monetary theory.

ELEANOR LANSING DULLES

Agricultural Reform in the United States, by John D. Black. New York: McGraw-Hill Publishing Company. 1929. x, 511 pp.

As the first administration of Gladstone was drawing to a close, Mr. Disraeli, in a speech at Manchester, characterized the Ministry as follows: "As I sat opposite to the Treasury bench, the ministers reminded me of a scene frequently encountered on the coast of South America, a row of extinct volcanos. Not a flame flickers on a single pallid crest. But there is an occasional earthquake, and ever and anon, the dark rumbling of the sea."

Professor Black's book reminds me strongly of this characterization. The various projects of agricultural relief, by which is meant political aid to agriculture, remind one of extinct volcanos, each of which, at one time or another, threatens a heavy drain upon the public treasury, and threatens also to sink the American farmer more deeply into the slough of despond but which, one by one, after loud eruptions in Congress, have lapsed into inactivity, leaving only one survivor, the Hoover Federal Farm Board, which is now so thoroughly condemned and discarded, that it will apparently soon join its predecessors in the limbo of political panaceas for economic distress.

Professor Black has spent a great deal of time and has apparently, with his collaborators, done an enormous amount of work to explain these attempts to relieve the farmer. He starts with a discussion of the present situation in agriculture, which he finds to be extremely bad, "still conspicuously below the levels of 1918 to 1920 in everything except the scale of living; and the higher scale of living has been maintained in good part out of capital." He follows with a discussion of the place of agriculture in national economy, which he summarizes in the statement that a Nation "should keep itself predominately rural if it can be accomplished without much sacrifice of the well being of either city or country people. We can go so far as to say that some measure of pecuniary advantage should be sacrificed in keeping the country rural to a considerable degree. In other words, a nation can afford even to burden the city industries a little and subsidize rural life." This introduces him to a discussion of the relief programs, which are briefly presented in chronological order. In considering the merits of these various plans, ending with the McNary-Haugen bill (the act creating the Federal Farm Board passed by the special session of Congress came

after the publication of the book) he considers first, the effect of agricultural surplus on prices and incomes. The first draft of this chapter is by Dr. George M. Peterson and Henry I. Richards, and is easily the most valuable portion of the book. It shows in great detail the effect of variations in yield of the leading farm crops from normal production upon prices, and also the effect of price changes upon subsequent production. The conclusion is established that "the gross values of cotton and potato crops have decreased with size. The gross value of wheat crops has increased with size, and probably those of corn and oats have decreased in both directions from near the middle, although the data as to the latter are not, by any means, conclusive. The gross value of annual meat production of all types has increased with volume, but at a diminishing rate; and the scanty post-war data point to a present tendency in the other direction." A further conclusion is drawn that "insofar as variations in size of crops are due to weather and related factors, the total expense of them increases with size, although by no means proportionately to it."

A further development of the same thesis, for which Dr. Mordecai Ezekiel of the Bureau of Agricultural Economics of the Department of Agriculture is given credit, shows the gains through holding crop surplus over until later years, and here the conclusion is that a program of stabilization by increasing the carry-over in years of large crops will not increase prices to growers. The Farm Board apparently did not avail itself of this study when it started "hold-over" speculation in wheat and cotton. On the other hand, Professor Black finds that "many producers would have greatly increased their income on the basis of 1926 to 1928, by planning the production of their crops on the basis of the announced probable effects of their plantings upon the prices likely to be received for the product, and by planning the marketing of their crops on the basis of the estimates of the probable course of prices in the marketing season."

Professor Black now takes up the great question of price raising by Government action. He finds, first, that the tariff on agricultural products, contrary to general belief, has a definite effect in raising prices. Present agricultural duties, he concludes, add $560,000,000 annually to farm values of protected products, and $800,000,000 to the retail values of these products, of which farms bear $260,000,000, leaving $280,000,000 net gain to agriculture from the tariff. He also concludes that the proposed increases in agricultural duties, most of which have been realized in the new tariff, will raise the cost of living by an additional $560,000,000, of which $400,000,000 will be borne by city families. His conclusion, therefore, is that tariff protection "within reason" has increased the retail value of farm products $1,360,000,000, of which $415,000,000 represents the net gain to the farmer.

I am surprised that Professor Black's conclusions have not been broadcast by the Republican Congressional Campaign Committee. They are well backed up by evidence and they would be of great service in a difficult political situation.

Professor Black now takes up the various plans which have materialized in legislation: The equalization fee plan, the plan of export debentures, stabilization corporations, etc. He also, as might be expected, has a plan of his own for improving the condition of the farmer, by raising farm prices at the expense of

the consumer. This he calls the domestic allotment plan, by which every farmer would be assigned a fixed quota of a crop beyond which he could not produce. Recognizing that reduced production is essential to increased prices, and that at present price levels the marginal farmer cannot succeed, Professor Black suggests that the Government should force curtailment of output by a system of allotment certificates which must be purchased by every processor, for example, every miller and packer, and which would be worth, allowing for differences in transportation cost, about the amount of the tariff duty on those commodities on which a duty is levied. This amount would be added to the price and so passed to the consumer. There is, of course, small choice in rotten apples, but of all the weird schemes to maintain the average American farmer in his present hopeless position, Professor Black's plan, by which the farmer is to be forced to curtail his output, while more fantastically improbable from the standpoint of legislation than the others, is more logical. The spokesmen of the Federal Farm Board are continually crusading without any noticeable effect, for the reduction in farm output, as the only means to agricultural salvation. Professor Black's plan proceeds from persuasion to compulsion. He would force the six million farmers to curtail their output and thereby improve their profits. Professor Black states that this is the "first time" this plan has been presented. Something like it, if memory serves, is now being tried in Russia. Professor Black would be, of course, the first to point out that his plan would have no chance of adoption. Its compulsory allotment feature is sufficient to damn it in the minds of all right thinking persons.

Professor Black briefly summarizes the scope of coöperative marketing and purchasing among the American farmers and gives this method his approval. He next, in Part 5, having considered in detail the mechanism of reform, now considers the reforms themselves. The reviewer agrees with Professor Black "that there is no pretence of thoroughness in the handling of these subjects." The aim instead has been to throw into relief the high spots of each of them, or to bring to the fore certain features ordinarily overlooked. The treatment is bold, not cautious and wavering—"intended rather to provoke thinking and discussion than to settle issues."

In this section of the book, he passes in rapid review, production, land utilization, marketing, transportation, immigration and farm labor, credit, public enterprise and taxation. If any criticism is to be made of this summary of the proposals for agricultural betterment, it is under the head of production. Professor Black reaches the conclusion that the progress of adjustment of agricultural production will be in a return of family size farms. He admits the feasibility of large scale farming, and while recognizing the benefits of chain farming, does not expect it to spread over the entire country. The people of the Southwest will not agree with him as to the impracticability of large scale farming in cotton, wheat and beef production. The large scale farm is producing an enormous supply and the scope of its operations is constantly growing. There is much reason to believe that this improvement will continue until the bulk of these products is produced on the factory system. The chain farming plan is quite as promising as Professor Black shows. By this plan, the owner of the farm, an

individual or a corporation, supplies on a profit sharing system an adequate proportion of the livestock and adequate feed and fertilizer to the tenants, and these can also be supplied to farm owners. The results have been extremely satisfactory, and there is no reason why this application of the principle of the operating holding company should not be extended throughout the United States. Professor Black's final conclusion is optimistic. He sees no danger of a food shortage. He expects the area under cultivation to be reduced and to be more generally limited to lands of high natural fertility. He forecasts a larger use of machinery, an increase in farm income of those farms which survive the process of elimination.

The most conspicuous defect in this interesting and otherwise well considered volume, is the failure to recognize that American farming, properly conducted, needs no public relief. The thrifty, energetic and well financed American farmer, admitting that he is a small minority of the total, is not an applicant for public aid. He is doing extremely well even at present price levels. His costs of production are far below present farm prices, whether operating on a large or small scale. He is probably making as much money in the aggregate as any other class of producers. This class of farmer is constantly expanding his operations and he will continue to expand them until he supplies the bulk of the demand for food and agricultural materials as he expands. The majority of farm operators, inefficient, poorly financed, and heavily in debt, will be driven out of their industry into the better paid occupations. It is almost beyond understanding how the agricultural economists, of whom Professor Black is a prominent member, have generally failed to recognize the significance of the development which is now in progress. Nothing can save the majority of American farmers. They are doomed to extinction. Examination of farming in almost any section of the country will establish this conclusion. During the last decade, in New York and Pennsylvania alone, the census figures show a reduction in the number of farms of 65,000. Later figures may be expected to show the same movement elsewhere. Throughout the country the agricultural revolution moves onward at an increasingly rapid pace and is transforming the character of American farming. The well meant, but pathetically feeble efforts of the Federal Farm Board to improve the situation may not be the last attempt to turn back the tide of progress, to hold these millions of inefficient farmers on the land, but it is certain that political action will never accomplish this result, and it is equally certain that in the long run the well being of this urban country will not be advanced by legislative action looking to the maintenance of an obsolete institution, the small American farm.

E. S. Mead

Planning and Control of Public Works, by Leo Wolman, with introduction by the Committee on Recent Economic Changes of the President's Conference on Unemployment. New York: National Bureau of Economic Research Series, No. 17. 1930. xxx, 260 pp.

This volume contains the first systematic factual survey of the conditions bearing on the possibility of using public works as stabilizers of industrial

activity. With the exception of a brief and general introductory report by the Committee on Economic Changes, it consists of the survey made by Dr. Wolman. The introductory report of the Committee, after summarizing its well-known theory of economic balance, indicates the place of this survey in the treatment of the problem of public works, and the place of public works in the larger problem of controlling industrial irregularities. The present report is to be followed by a study of "the effects of varying interest rates or capital costs upon the chief types of construction," and by a more fundamental study of the profit incentive as manifested during the last ten years in this country. More immediately, it is to be followed by a study of relative changes in prices for the products of different groups. Public construction is regarded as "an important step, not as a large scale measure of emergency relief, but in the group of active balancing factors, that one which is closely related to the movement of interest rates and to the volume of employment."

Dr. Wolman's report, after tracing the great growth of municipal construction expenditures in this country, plunges into an intensive study of the matter in New York City and New York State. The amount expended in recent years for different types of construction is shown, and the sources of funds—taxes, long-term bonds and short-term borrowing. Changing interest rates are shown to cause a shift between short-term and long-term financing. The margin of unused constitutional borrowing power is traced. The procedure involved in determining upon projects and getting them under way is shown in all its ponderous detail—most discouraging to advocates of rapid mobilization in this field. The period required to finish typical projects is indicated, as well as the natural distribution of expenses over this period. Here the lesson is strengthened that quick results from new projects are not to be looked for, as outlays in the opening stages are necessarily small. The number of purchasing agencies is indicated, the moral being that centralized purchasing is most favorable to control of expenditures. The number of persons employed is estimated, and also the volume of work likely to be done in the near future.

Following a similar survey for the Federal Government, the report broadens to a general estimate of amounts of public and private construction. The estimated total for both is approximately 10 billions for 1928; the total of public construction being 3½ billions, with 887,000 persons employed. The doubtful and conflicting nature of the data underlying these estimates is fully indicated.

The report then treats, on a national scale, some of the topics already touched on in the more intensive surveys; road building, financing and future projects. Some effect of repetition is introduced by this cross-classification of material, but this is hardly a defect, as each type of treatment is essential.

In the two concluding chapters the problem of control is directly grappled with. Public officials are shown to be on the whole more concerned with getting things done when they are wanted than with contributing to a nation-wide stabilization program. Difficulties of this sort are shown to be inherent in the nature of local governments, but some cities have developed long-range programs which afford better promise of control. Past experience of emergency relief is shown to have been disappointing, and the holding back of work to

create a "reserve" to be inherently difficult. More promise is seen in the speeding up of works already under way, with the aid of proper financial and administrative preparedness. The volume of direct increase in employment available from such sources is obviously small compared to our total volume of unemployment, but hope is held out that the indirect effects will be larger, through stimulating other industries and sustaining general purchasing power. The crucial point is held to be not so much the bulk of increased work done as the bringing about of increases at precisely the right time—admittedly a difficult task, requiring delicate and accurate business barometrics and more responsive governmental machinery than exists at present.

The report is cautious and temperate in tone, and the reader leaves it with an impression that the study of existing facts alone, though highly essential to a solution of the problems involved, is not sufficient in itself for that purpose. No quantitative estimate is offered of the margin of controllable elasticity in the total budget of public or private construction, and indeed such an estimate would necessarily be sheer conjecture. One large question is the extent to which the natural seasonal variation of construction work can be overcome so as to aid unemployment at the worst time, in the winter. Another question is how much additional indirect effect in stimulating general employment may be expected from setting a given number of persons at work on public construction. Perhaps nothing can give a final answer—not even the results of experience—but it seems possible that on this point economic theory has not yet given the aid of which its methods are capable. However that may be, Dr. Wolman's report, in marshalling the necessary facts, takes an essential forward step toward the meeting of our national duty in this matter.

J. M. Clark

Columbia University

Prosperity Reserves of Public Works, by Vernon Arthur Mund. Philadelphia: American Academy of Political and Social Science. 1930. 49 pp.

In this paper Mr. Mund has attempted a comprehensive examination of an idea which for some time past, and particularly recently, has evoked considerable interest—that of controlling public construction to make it serve as a balance wheel of business activity.

European, Canadian and American experiences with attempts to extend public works during a period of depression are first rapidly sketched. It is largely a record of failure and disappointment, with the recognition gradually emerging of the fundamental difference between relief work and public work. The central chapter of the paper, the third, discusses the theory and scope of public works, and contains an interesting attempt to measure the effects of public construction by means of an analysis of the activity indirectly generated by the money payments expended directly upon it. A proposal is also here advanced to use local employment and payroll indexes for the correct timing of public works. A chapter on the relation between public works and unemployment, with special reference to the state of Washington, and one on administrative

technique, discussing practical difficulties and suggesting practical measures, conclude the study.

It can be seen that Mr. Mund has covered a great deal of ground in some 25,000 words. In touching upon so many large and thorny problems in such small compass he has been able to do less than justice either to them or himself: the problem of business cycles and their control, for instance, occupies but four pages. What Mr. Mund has to say about the theory, probable effects, proper timing and other aspects of public works is of sufficient interest to make us regret that they could not be discussed more fully by reason of the sacrifice of detail to comprehensiveness. The paper was prepared before the publication of Dr. Wolman's full quantitative report on the *Planning and Control of Public Works*, so that some of the statistics used have since been superseded. Thus the estimates of annual public construction in the United States cited on page 8 are now known greatly to under-represent its volume. But this recent large accretion of factual and descriptive material has also somewhat shifted the emphasis in the theoretic discussion of the problem. Mr. Mund is in substantial agreement with Professor Dickinson in envisaging a public works plan which will "push the peak off the mountain of prosperity into the valley of depression." Indeed, the root idea of a "prosperity reserve" necessarily implies the deliberate postponement of selected construction projects with the intention of later using them as a stimulant to business. Apart from the inherent dangers and uncertainties of such a plan it becomes increasingly clear as the realistic details of the problem are examined that the deliberate retardation of public works presents practical difficulties of a magnitude to give pause to the most stout-hearted. In view of the steeply rising trend shown by public construction, it would seem that the key to control lies rather in making possible when needed a well-timed acceleration of their volume. Still, it is well to have the counter proposal put forward and Mr. Mund's comprehensive and lucid paper is to be welcomed for the important questions it raises and the many suggestive ideas thrown out.

ARTHUR D. GAYER

National Bureau of Economic Research

The Money Value of a Man, by Louis I. Dublin and Alfred J. Lotka. New York: The Ronald Press Company. 1930. xv, 264 pp.

This book is concerned essentially with the value of a man to his dependents, that is, to those who have a direct interest in his earnings. It is intended to aid in solving the problem of how much insurance a family man should carry, details being given in a set of tables (pp. 177–256) showing the value of a man in a wide range of circumstances: at various ages; $1,000 to $10,000 maximum annual earnings; normal and excess mortality; net and gross future earnings; 3½ per cent and 4½ per cent annual discount rate.

For a man of thirty years of age with maximum annual earnings of $2,500 (at the age of forty-three) and with normal mortality, the present worth (at 3½ per cent discount) of the gross future earnings is thus $42,350, the present worth of

the future expenditure for his upkeep $11,400, and the present worth of the net future earnings consequently $30,950. The present worth of his future earnings represents the economic interest of his actual dependents in his life activities. If he is killed in an accident, the present worth of his net future earnings ($30,950) represents the economic loss to his family; if he has not been actually killed, but is totally incapacitated for life (without being impaired in his vitality) it is his gross future earnings ($42,350) that represent the economic loss to his dependents.

How much life insurance should such a man carry? Complete coverage of his whole value ($30,950) would mean that he should have to pay an annual premium of about $600 or about one-fourth of his annual earnings. This of course is out of the question. The authors suggest that he pay $100 a year. But what would then be his reward? "A monthly income of $100 will be paid by the insurance company to the widow, out of the proceeds of the insurance, and such payments can be extended over a period of nearly five years." This does not sound particularly attractive and it is easy to understand that so far very few men of moderate means have done what the authors advise them to do.

The $10,000 man, according to the authors, should spend 12 per cent of his income for insurance. By paying an annual premium of $1,200 from the age of thirty years on, he would provide for his family a definite annual income of $4,000 for twenty years after his death. But the $10,000 man, as the authors conceive him, has $3,100 only at the age of thirty. He would actually have to start with an annual premium of 40 per cent of his income in order to secure to his family 40 per cent of his maximum annual earnings for twenty years after his death. While it is true that a $10,000 man can afford to spend a higher percentage of his income for insurance than a $2,500 man, the fact that his income in early life is comparatively much smaller than that of the $2,500 man, necessarily prevents him likewise from buying an insurance covering more than a fraction of his "net future earnings."

These most ingenious computations of "the money value of a man" may then prove to be of less practical value for the general public than the authors expect. But their book will help judges, juries, and compensation boards in making fair adjudications in case of accidents; and even aside from any immediate usefulness, it is to be highly welcomed as a thorough and suggestive treatment of a very important and intricate problem.

R. R. KUCZYNSKI

Emigration from the British Isles, by W. A. Carrothers. London: P. S. King & Son, Ltd. 1929. 328 pp.

This book is a very interesting though detailed study of the economic and political doctrines behind the British emigration policies. In the first two chapters, the author traces in detail the streams of migration from the British Isles to Canada and Australia, the difficulties encountered by the early settlers, and the effects which were produced by the transportation of convicts to these colonies.

In his chapter on "Malthusianism and Emigration," the writer traces the effect of the economic distress in Ireland, and of the Malthusian theories on emigration

from Ireland and England during the first quarter of the nineteenth century. The failure of the potato crop in 1822 left the people of Ireland in great distress, not because there was not enough food in the country, but because of "the want of adequate means of purchasing it, or in other words, from the want of profitable employment." The Malthusian doctrines that the population tends to outstrip the means of subsistence and that there is a fixed wage fund from which all wages must be paid influenced the thought that the government ought to assist the emigration of people from the British Isles, especially of paupers from Ireland, where the population was considered redundant in relation to the food supply. Malthus, and William Horton, who was influenced by him, were the principal proponents of assisted emigration as a remedy for the economic and social ills of the time. Michael Thomas Sadler and William Cobbett were the chief spokesmen against the theory that the remedy lay in getting rid of the population by emigration.

Several chapters of the book are devoted to tracing the important influence which Gibbon Wakefield's theories exercised on the British emigration policies. According to the author, "there is no doubt that Wakefield exercised a very powerful influence on British colonial policy, and did much to bind the various parts of the Empire together on the solid basis of independence and interdependence."

The social conditions which affected immigration during the Wakefield period, 1831–1850, and the effect of the Irish famine upon Irish immigration, are discussed by the author in two chapters. Owing to the bad social and economic conditions during this period, emigration from the British Isles was especially pronounced.

Professor Carrothers traces the effects of periods of depressions and prosperity upon emigration from the British Isles and shows how in times of plenty there was a lull in emigration; while, in periods of depression, emigration received an impetus. He also shows that economic conditions in the colonies, and in the United States, influenced the tides of emigration from the British Isles.

During the World War, emigration, of course, stopped, but after the War, emigration of ex-service men and women was encouraged by the government by the inauguration of the Free Passage Scheme. "This grant in aid of emigration was not an indication of any change of policy on the part of the British Government with regard to State-aided emigration. This aid was given to a special class and was looked upon as being of a special character." The Overseas Settlement Act was passed in 1922; and, since then 302,000 people were assisted to migrate. Professor Carrothers points out that even with this policy of assisted migration, the movement was smaller than under the pre-war system of unassisted migration.

In the last two chapters of the book, the author discusses "Special Emigration Problems," and "The Migration Problem of Today." In the former chapter, he discusses the question of migration of women and points out, among other things, that the ideal age for a woman to migrate is between the ages of 20 and 30. He also discusses here the migration of children and juveniles, and reviews the experience with such migration from the British Isles. The final chapter

treats the possibilities of further migration to the Dominions. While there will continue to be opportunities for the care of an increasing population over and above the native natural increase in the Overseas Dominions, it would be disastrous to attempt to settle large numbers of people in the Dominions, without giving them proper economic opportunities. Professor Carrothers thinks "that there is little doubt that in the near future British industry will have no difficulty in absorbing the population increase," and that "the Dominions will be faced with the serious problem of difficulty in securing the desired population additions from the British Isles to assist in the development of their economic resources."

There is probably no better book available for those who desire to get a history of the British colonial migration policies from the early settlements in Canada and Australia to date.

Louis Bloch

California Department of Industrial Relations

Birth, Stillbirth, and Infant Mortality Statistics for the Birth Registration Area of the United States, 1928. Washington, D. C.: Bureau of the Census. 1930. 319 pp.

The report for 1928, the fourteenth since the establishment of the Birth Registration Area in 1915 includes data for all states but Nevada, New Mexico, South Dakota, and Texas. Since 1928 all but Texas have been admitted.

The number of births registered in 1928 was 2,233,149, the crude birth rate being 19.7 per 1,000. Deaths numbered 1,361,987, or 12 per 1,000. The crude rate of natural increase was 7.7 per 1,000 for the 44 states which contained 94.4 per cent of the estimated population. Births did not exceed deaths for all categories of the population. In 58 of 719 cities deaths exceeded births. Among the colored, deaths exceeded births in 16 states and in 90 of 143 cities. When correction is made for age composition and the *true* rate of natural increase is determined, the rate of 7.7 per 1,000 becomes 2.1. In many states and in the cities there is no longer any *true* natural increase in the population.[1]

The crude birth rate for the registration area and for the urban and the rural classes of population has fallen steadily. The rate for the area as a whole declined 9 per cent in decreasing from 22.5 in 1922 to 20.4 in 1927. In 1929 the rate was 18.9. In 1928 the crude rate, 19.7, exceeded only those in Belgium, England and Wales, France, Germany, New Zealand, Scandinavia, and Switzerland. Between 1922 and 1927 the urban rate fell 6 per cent from 22.7 to 21.4; the rural rate 9 per cent from 22.3 to 18.8. Favorable age composition accounts for the higher urban rate.

Foreign families exceeded in size both native and colored families. The number of children born to women who bore children in 1928 was 3.9 for foreign-born mothers, 3.7 for colored mothers and 3 for native-white mothers. The average for native-white mothers ranged between 3.8 in South Carolina and 2.4 in Cali-

[1] See P. K. Whelpton, this Journal, September, 1929, p. 238; *American Journal of Sociology*, May, 1930, p. 872; Dublin and Lotka, *Publication of the American Sociological Society*, Vol. 24, May, 1930, pp. 106–114.

fornia. Of the children born to native-white mothers 91.7 per cent were living; of those born to foreign-born mothers, 87.8 per cent; of those born to colored mothers, 87.5 per cent.

Considering only data for mothers 35 or more years old the highest average number of children born and living is found among coal mine operators, the lowest among dentists, architects, physicians and surgeons.

While the spread of birth control is reducing these differences in the sizes of families classed according to occupation of the father, the effect of this reduction of differences will not be conspicuous until present families with parents under 30 will have been completed.

The ratio of illegitimate births to 1,000 total births was 18.2 for native white and 6.7 for foreign whites. For colored the ratio was 136.6. Except for the colored the ratio was higher in urban centers.

Stillbirths per 100 live births numbered 3.7 for urban whites and 3.3 for rural whites. Among the colored the urban ratio was 8.9, the rural, 7.8.

The statistics for infant mortality reveal that there is much room for improvement. The infant mortality rate for the registration area was 68.7 per 1,000 births and exceeded that of Australia, England and Wales, Norway, Netherlands, New Zealand and Switzerland. Among children of native mothers the rate was 61.5; among foreign, 71.5; among Negroes, 105.9. Rates for states ranged between 46.6 in Oregon and 141.5 in Arizona. The New Zealand rate of 36.2 indicates how infant mortality can be curbed. The rate for the United States exceeds the New Zealand rate chiefly because of the heavier incidence of diarrhea and enteritis, premature births, bronchitis, broncho-pneumonia, influenza and pneumonia.

The present report is well indexed. Unfortunately it is not indicated how full registration of births is at present in the various states. Births ought to be classified by sex, color and age of mother and by country of birth of mother not only by state but for the urban and the rural population of each state. It is to be hoped that specific birth rates will be given for the urban and rural white female population classed by nativity of mother and for the urban and the rural colored population when the new census data on age composition become available.

JOSEPH J. SPENGLER

Operating Results of Department and Specialty Stores in 1929, by Carl N. Schmalz. Bulletin No. 83, Bureau of Business Research, Harvard University. June, 1930. 66 pp.

Yearly Standards of Performance for Department Stores: 1928–1929, by Edgar H. Gault. University of Michigan Business Studies, Vol. II, No. 10. July, 1930. 111 pp.

Monthly Standards of Performance for Department Stores: 1928–1929, by Edgar H. Gault. University of Michigan Business Studies, Vol. II, No. 6. March, 1930. 111 pp.

Department stores during the last several years have experienced a rising tide of red ink. Business expense has been mounting while gross margins have

remained about the same. Net profits have declined as has the proportion of profitable stores. Almost two-thirds of the stores upon which Professor Schmalz's study is based showed an operating loss.

The first mentioned study of Professor Gault, *Yearly Standards of Performance for Department Stores: 1928–1929*, reveals: (1) an increase in number of individual departments with lessened volume; (2) an increase in the number of departments which register a loss; (3) a decrease in the typical net loss from year to year, since 1927; (4) a decrease in the net profit of profitable departments.

This condition has not come about overnight. It has been evident for several years and was the subject of frequent discussions among the lesser department store executives while their superiors refused to be concerned, and, following the traditional behavior of Pollyanna, kept on whistling to keep up their courage. This attitude of department store owners was greatly encouraged by the less reputable part of the trade press which, for reasons of its own, constituted itself the official cheer leader of department store retailing.

Were department store difficulties subject to solution by facts and figures, their troubles could easily be solved. Aside from public utilities, few businesses or industries know about themselves as much as department stores. This is due almost wholly to four research agencies, The National Retail Dry Goods Association—the principal trade body of the industry, and one of the best—and the Bureaus of Business Research of Harvard, Michigan and Ohio Universities.

Harvard has pioneered in this field. The study of Professor Schmalz is the 1929 continuation of the annual series of studies on operating results of department stores and specialty stores begun in 1921. The task has been performed in a more satisfactory manner from year to year. Professor Schmalz's study is the most comprehensive of the series, both in the breadth of information and refinement of statistical methods.

Professor Schmalz's bulletin has two minor defects, both temporary. As a result of new definitions of expense items, *rent*, *interest*, *insurance*, *taxes*, *repairs*, and *depreciation*, made by the Controllers' Congress of the National Retail Dry Goods Association, and used by Professor Schmalz, a detailed comparison of these items with identical items for previous years is difficult. Another minor difficulty is due to the fact that operating results in 1929 are presented in three volume classifications instead of two as has been the practice heretofore. Both of these defects will wear off, of course, as the years roll by.

While Professor Schmalz's study mainly represents results of operations of the larger department stores, the Michigan studies cover department stores with a volume of business up to $3,300,000. Taken together, the Harvard and Michigan studies furnish a reliable, comprehensive, and representative picture of department store operation in the United States.

The usefulness of these studies may readily become apparent when it is stated that one rarely meets an enlightened department store executive who is not familiar with them. The Harvard studies have actually become operating guidebooks in many a department store.

The collection of operating data by the Michigan Bureau of Business Research

began in 1926. The relationship between the stores and the Michigan Bureau was conceived and consummated, according to the Director of the Michigan Bureau, by Professor Schmalz, the present author of the Harvard study before he transferred his activities to Harvard.

Professor Gault's second study on *Monthly Standards of Performance for Department Stores* is an interesting analysis of "seasonality" of certain factors of department store performance. It deals largely with month to month variations in sales, selling salaries, mark-downs, newspaper advertising expense, gross margins, and similar items. Standard performance ratios in 1928 and 1929 are given for thirty-five individual departments, as follows: Per cent of year's business done during each month, per cent increase or decrease in sales over same month of preceding year; monthly mark-downs as a per cent of sales for same month; monthly selling salaries as percentage of sales for same month; monthly newspaper advertising expense as per cent of sales of same months.

The Michigan studies of Professor Gault, serve to make the Harvard picture more readily understandable. Harvard, for instance, merely reports an average merchandise turnover of so many times a year. Michigan supplements this by presenting figures showing the actual age of merchandise by departments. The meaning of slow turnover becomes very clear when figures of the proportion of merchandise older than say, six months, is presented, by departments.

Professor Schmalz's study has a good index. Professor Gault's studies have no such convenience. Inasmuch as the most extensive use of these studies is made by busy men, an index such as Professor Schmalz's would add greatly to the value of Professor Gault's studies.

BORIS EMMET

Stanford University

Index Numbers Elucidated, by Willford Isbell King. New York: Longmans, Green and Company. 1930. xx, 226 pp.

Largely by means of well selected illustrations, the book under review tends to clarify the significance of index numbers. Much emphasis is placed on the problem of sampling as the main feature of the problem of index numbers. The fact is brought out that this feature of the problem is usually almost entirely overlooked or treated as a matter of no particular significance. It is contended that because of this oversight, few "students of the subject seem to have realized that the only formula test which has any merit is: Does this formula, when applied to a sample, give results, the fluctuations in which closely resemble those occurring in the totality of items?"

While the reviewer is in entire agreement with the book on the importance of the sampling problem in relation to index numbers it seems that an appropriate test based on sampling considerations would not, after all, be exactly a substitute for the well known tests such as the circular test, the factor reversal test, or the time reversal test. These latter tests would be likely to serve useful purposes in some cases even if we had the totality of items in the universe of discourse to analyze.

On page 54, it is stated that "the mission of the index number is to make the

sample tell the story of the totality." This is a fine ideal, but there seems to be involved in its complete attainment one of the most difficult problems of mathematical statistics; that is, the problem of drawing logical inferences about a totality from a sample.

On account of the paramount importance attached to sampling in relation to index numbers, we naturally inquire about the contribution that has been made to this subject. On pages 63–64, we are told about one of the most simple and effective ways, by means of subdivisions into halves, of determining whether a sample is or is not large enough to give a dependable result. The criterion described no doubt serves some useful purposes, but no clear exposition is given of the logic which supports it. The reviewer believes many errors can be avoided in statistics by subdivision of data, but the underlying rationale of the process is difficult. It is probably a common sense statement to say that the process serves at least as a simple and important check on gross errors, but there is a considerable chance that the test described may exclude important data that should be retained.

In the discussion of random versus proportional sampling, it is very appropriately stated that "sampling at random is not a method which, inherently, has any virtue," and that every sample ought to contain as nearly as possible the same proportion of items of each class entering the totality. With this position the reviewer is in agreement. In fact, it seems fairly obvious that random sampling should begin only after all that is practicable has been done in the line of systematic classification. Finally, however, it is usually necessary to draw items at random within the classes. Random sampling is no substitute for systematic classification of data. There is a statement (p. 75) that random sampling is a simple process. The reviewer doubts the correctness of this statement. It is fairly well recognized that pretty careful procedures are necessary in drawing random samples even in theoretically pure games of chance.

In conclusion, it is the judgment of the reviewer that the book will serve a very useful purpose in stimulating thought by emphasizing the importance of the sampling problem in relation to index numbers.

H. L. Rietz

Mortality in Retail Trade, by Edmund D. McGarry. Studies in Business No. 4. University of Buffalo Bureau of Business and Social Research. 1930. xix, 188 pp.

This volume, which appears as No. 4 of the University of Buffalo Studies in Business, is an expansion in a more comprehensive form of Monograph No. 1 of this series of studies which appeared in 1928 under the title *Retail Trade Mortality in Buffalo, 1918–1928*. The author explains that in the earlier study the basic statistical data regarding entrances into and exits from certain retail fields were presented with but little interpretation. The present book includes computations of mortality rates and the life expectancy of stores studied and a number of chapters on economic aspects of store mortality.

An enumeration of the more important chapter headings indicates the scope and character of the present monograph. After a section of several chapters

dealing with the mortality data for independent grocery stores, drug stores, hardware stores, and shoe stores, there appear a series of chapters concerning Reasons for Entrance, Reasons for Withdrawal, Effect of Economic Changes, Mortality in Relation to Population, Mortality in Relation to Chain Stores, and Economic Consequences.

So far as the mortality data are concerned, the author concludes that for the period under investigation there has been a distinct tendency for the number of drug, grocery, and hardware stores to increase and for the number of shoe stores to decline. Drug stores have grown most rapidly, but all three of the types of stores showing increase have increased more rapidly than population. This tendency was particularly true during the first half of the period and seems to be perhaps reversed in the last year or two.

Among the general chapters, that dealing with mortality of independent retailers in relation to chain stores is of particular interest because of the extensive discussion which has been aroused by the expansion of the chain systems. On this point it is the author's observation that there is little indication that the development of chain stores has increased the mortality rate among independent stores. It is stated that there is a tendency at present for chain stores to replace independent stores in the higher income class neighborhoods and to reduce the number of those entering the retail business. The result is a tendency toward a reduction of the total number of independent retail stores.

LEVERETT S. LYON

The Brookings Institution

Money Rates and Money Markets in the United States, by Winfield W. Riefler. New York and London: Harper and Brothers. 1930. xviii, 259 pp.

This descriptive treatment of the American money market begins with a classification under three headings: long-term open markets, short-term open markets, and short-term customers' markets. Rates in each type of market have individual characteristics as to amplitude and timing of fluctuations, but beyond this "all three classes of rates respond to a common pull that affects the market as a whole." The primary factor in fluctuations of money rates is defined by the author as changes in the amount of member bank borrowing from the reserve banks. This factor derives its importance in part from the fact that by custom and practice member bank borrowing usually arises not from a desire to relend at a profit but from a desire to meet a need of more or less temporary character. To be permanently in debt to the reserve is looked askance at; hence rediscounting at the reserve is usually in the nature of an emergency or marginal demand. Statistically, a curve of volume of discounts of reserve banks synchronizes closely with a curve of short-term open-market rates. According to this point of view, open-market transactions by reserve banks influence money rates by the medium of either forcing member banks to rediscount, or of enabling them to pay off existing rediscounts. Riefler adds to knowledge of these relationships by a more precise and detailed description than has hitherto been available.

An important amount of newly gathered descriptive material dealing with customer loan rates is presented and affords useful measurements of a loan market

hitherto neglected in money market literature. Differentials in customer rates as between various geographical regions receive special attention and are a noteworthy contribution to our factual knowledge in that field.

The behavior of long-term money rates receives relatively slight attention and lacks the precision employed by the author in dealing with other money markets. The discrepancies between fluctuations of different types of long-term obligations, particularly of first grade as contrasted with second grade obligations, are inadequately developed.

Having built his case around the primary importance of member bank indebtedness as a factor influencing money rates, and having stressed the interrelations and similarities of fluctuations in all types of money markets, the author proceeds to show the kinds of factors which lead to changes in member bank indebtedness. Such factors include acceptances bought by the reserve banks, United States securities bought, gold stock, Treasury currency, currency in circulation, members' reserve balances, and other items. These factors can be stated in statistical terms so that their fluctuations can be traced with reasonable accuracy. A detailed historical survey of such fluctuations from 1917 to 1928 is furnished.

A chapter is devoted to the relation of the interest rate of economic theory to the interest rate of the money market. The treatment here strikes the reviewer as fragmentary and inadequate. The abstract issues involved in distinguishing between supply and demand of capital and supply and demand of money do not get clarity of statement and one feels that the outcome of this particular segment of the book does not lead anywhere. Probably this is because the analysis does not go seriously into the relation of volume of total credit to the general price level and in turn to the pace of business activity.

The adoption of "demand" for reserve bank credit as the central point of view in the whole analysis carries implications which seem to the reviewer to be open to serious criticism. These implications are that "demand" is a more or less autonomous force, coming spontaneously from the decisions of private bankers who are trying to accommodate business. Since they know how much credit they want, it would be artificial interference for Federal reserve banks to try to force funds into use during periods of deflation. All of these inferences are implicit rather than explicit, but they are reflected in the basic principles of analysis none the less. And if accepted, they constitute a strong case for non-control of credit by central banks, especially in practice of non-intervention in periods of drastic liquidation and deflation. In brief, the factual and descriptive contribution by the author is of first importance and constitutes a manual with which every business economist should be familiar, but in the larger implications and broader premises of the analysis it invites thoughtful criticism.

LIONEL D. EDIE

Ten Thousand Small Loans, by Louis K. Robinson and Maude E. Stearns. New York: Russell Sage Foundation. 1930. 159 pp.

In 1923 when the data of which this book is a digest were collected, eighteen states had adopted some form of the Uniform Small Loan Law which had been

launched in 1911 under the banner of the Russell Sage Foundation. Most of the great industrial states were included, and nearly half the population of the country. Since 1923 six additional states have adopted some form of this law, which applies to loans of a maximum of $300, usually secured by chattel mortgage. It limits the rate of interest to 3 or 3½ per cent per month on unpaid balances, and requires licenses to be bonded and to submit to state supervision.

In order to obtain a cross-section description of those using the facilities of these state supervised lending agencies, a questionnaire containing thirty questions was sent to ten thousand borrowers over a period of thirteen months from August, 1922, until September, 1923. Two hundred and eleven offices cooperated, covering 109 cities in 17 states.

It has been assumed by the lay public that the small loan borrower is low in the economic scale; he is frequently pictured as a man out of work and in need of funds to purchase the necessities of life. The answers to this questionnaire reveal that 9,697 of the ten thousand borrowers were usually employed and only 8 per cent of these unemployed at the time the loan was made—4.6 per cent from lack of work, 2 per cent from disability, 1.4 per cent from other causes. Eighty per cent of all the borrowers carried life insurance and 33 per cent owned real estate.

The most common amount borrowed was $100, with $50 next in frequency. It is interesting to compare these figures with those of Dr. Willford I. King in his recent study of small loan conditions in New Jersey in 1929. He found the modal size of loan to be $100 to $150, with a further modal figure of loans between $250 and $300.

Though the book is obviously not intended for general reading its precise exposition and lack of generalizations commend it highly to the student and legislator who will find it invaluable for its great detail which includes 71 tables and comparisons of the age, race and marital status of the borrowers with the 1920 census figures.

J. G. Rolph

The Amalgamated Bank of New York